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THE
DUODENAL TUBE
AND ITS POSSIBILITIES

By

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To

His dear friend and highly esteemed colleague,
Chas. G. Stockton, M. D.,
Professor of Medicine at the University of
Buffalo, New York,
This book is respectfully dedicated.

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PREFACE

In one decade the duodenal tube has shown its great value in the diagnosis as well as in the treatment of a variety of diseases. In a few instances this comparatively new instrument has saved some lives, which otherwise would have been lost. The diagnostic possibilities, while already numerous, are far from having been exhausted. It will probably take decades to elucidate all the details of the secretions, it makes possible to obtain, in pure form, for analysis. Already a number of investigators here and abroad have busied themselves with various problems concerning the duodenum, pancreas and liver, as can be discerned by means of the tube. The probability is that the number of workers in this field will steadily increase.

In this book I intend to deliver a few lectures on the duodenal tube, giving a full resumé of what has been thus far accomplished by it. The purpose of these lectures is twofold: (1) to acquaint my colleagues with the actual facts obtained by the duodenal tube, in a manner that they can make use of them; (2) to facilitate the work of others who are willing to enter this field of investigations for further study.

MAX EINHORN.

NEW YORK CITY, N. Y.,
June, 1920.

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THE DUODENAL TUBE
AND
ITS POSSIBILITIES

CHAPTER I

THE DUODENAL TUBE AND ITS CONGENERS

HISTORICAL SKETCH OF THE DEVELOPMENT OF THE DUODENAL TUBE[1]

Shortly after the stomach pump was discovered by Kussmaul examination of the gastric contents became of great importance for the diagnosis of diseases of the stomach. As soon as physicians appreciated the value of the stomach tube it was felt it would be desirable to be able to examine also the secretion of the organs farther down, particularly the pancreas, because it was known that the pancreas is of much greater value to the process of digestion than the stomach. But at first this wish—namely, to reach the secretion and analyze it—appeared to be impossible of fulfilment.

For a number of years the first attempt to reach the pancreatic secretion was abandoned until Boas,[2] about 1889, published a paper in which he said that he had succeeded, by the introduction of a stomach tube into the fasting stomach and massaging the liver, in obtaining a fluid from the stomach which was regurgitated there from the duodenum. It gave the reaction of the pancreatic secretion. While it is possible, in rare instances, to succeed in bringing on such a regurgitation in the fasting condition, it is naturally not a procedure that can be done in a routine way. If there is, for instance, gastric juice in the stomach already the results will be vitiated.

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[1] American Journal of the Medical Sciences, February, 1916, No. 2, vol. cli, p. 202. Copyright, 1916, by Lea and Febiger.

[2] Ueber Darmsaftgewinnung beim Menschen, Centralblatt f. klin. Med., 1889, No. 6, p. 97.

The second step was undertaken by Boldyreff,[1] a Russian physician working in the laboratory of Professor Pawloff. He noticed on animals with gastric fistulæ that when they were given oil or fat a regurgitation from the duodenum into the stomach took place, and he suggested to make use of this phenomenon for clinical purposes. Volhard[2] then applied this test in practice. He gave oil or butter and half an hour later washed out the stomach. This method also is not applicable to all cases. In many regurgitation does not take place, or the regurgitated matter is mixed up with gastric juice, and is of no value.

Other more direct attempts have been made to obtain the duodenal secretion.

In 1897 Hemmeter[3] described a method by which he thought he could introduce instruments, into the duodenum. A brief consideration of the construction of his instrument will make it clear that it is difficult to accomplish with this apparatus what Hemmeter claims.

Hemmeter's instrument consists of a rubber bag that

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[1] Der Uebertritt des natürlichen Gemisches aus Pankreassaft, Darmsaft und Galle in den Magen, Pflüger's Arch. f. Physiol., 1908, p. 13.

[2] Ueber die Untersuchung des Pankreassaftes beim Menschen und eine Methode der quantitativen Trypsin-bestimmung, Münch. med. Wchnschr., 1907, p. 403.

[3] Versuche über Intubation des Duodenums, Archiv f. Verdaungskr.; 1897, Bd. 2, p. 85.

resembles the stomach, and this bag contains in its upper segment a groove or a canal for another tube which is inserted into the duodenum through the pylorus as soon as the bag has been introduced and had been filled with air.

The trouble with this instrument is that stomachs vary in size and configuration. One can not obtain in advance a mold of any particular stomach, so that the bag will tally exactly with the shape of the stomach, and therefore it is impossible to say whether the opening of the groove in the bag is really opposite the pylorus. After the bag is in, the tube is pushed down, and Hemmeter says that he then succeeds in pushing the tube into the duodenum through the pylorus. I do not know whether he succeeded or not. Hemmeter asserts that he obtained pancreatic secretion. This, however, is no proof that the secretion came from the duodenum through the tube, but I assume, rather, that he got it from the stomach. I do not believe it is easy to obtain pancreatic secretion by Hemmeter's instrument.

The second clinician to try to reach the duodenum directly by means of instruments was Kuhn.[1] This was about one year later. He constructed tubes with a metal spiral inside. The spiral served to prevent too much bending and kinking and doubling upon itself. He then took a long stomach tube, put the metal spiral inside and manipulated it for a long time, until he thought he had reached the duodenum. He also maintained that he did get the pancreatic secretion. *X*-ray examination was not yet in vogue and so could not confirm the position of the tube in the duodenum. Kuhn's tube did not differ much from a stomach tube. I also experimented with it, but never succeeded in entering the duodenum with it. It certainly was a difficult procedure, both for the physician and for the patient. It is impractical.

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[1] Sondierungen am Magen, Pylorus und Duodenum des Menschen, Archiv f. Verdauungskr., 1898, p. 19.

After the publication of Kuhn's article Hemmeter gave up the use of the bag and tube and used Kuhn's instrument. This was the way things stood for a number of years. Then gradually I evolved the present instrument from various experiments and procedures that I will now give in detail.

I tried to find a method of testing the motor function of the intestines. For this purpose I[1] made use of porcelain beads, sifted the stool, and observed the time it took for them to reappear in the stool. This was described about fifteen years ago.

Later, I desired not only to test the motor but also the digestive functions of the stomach and intestines. Various test substances (as meat, catgut, potato, fat, etc.) were attached to little beads.

The question now came up whether the digestion of the various test substances took place in the stomach or in the intestines.

In order to differentiate this,[2] I gave patients beads with test substances attached to a thread, arranged so that the thread was about 53 cm. long from the teeth, so that the beads could not reach the duodenum. After four to five hours I pulled up the thread and looked whether the substance was still left. I worked with beads and thread so that the beads could not pass the pylorus. Thus I found which of the substances was digested entirely in the stomach. Those test substances which remained intact in the stomach but were missing on the beads when found in the feces must, therefore, have been digested beyond the stomach—in the intestine.

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[1] Diseases of the Intestine, 1904, 2d edition, p. 62.

[2] A New Method of Testing the Functions of the Digestive Apparatus, Med. Record, February 10, 1906.

A short time later, while dealing with the question of the patency of the pylorus, I conceived the idea of giving beads to see whether they would pass the pylorus, in order to thus measure its permeability. This paper was published in 1908.[1]

In order to know whether the pylorus was permeable I had to have some substance which would change when it reached the duodenum and would not change in the stomach.

I attached to the thread one bead and a little bag containing a piece of dimethylamidoazobenzol agar—the idea of using agar was to have a firmer substance than, for instance, test paper, so that the change of reaction should not take place too abruptly, but should proceed slowly.

Attach to the thread one bead at thirty inches from the lips, with dimethylamidoazobenzol agar, another one at twenty inches, likewise with dimethylamidoazobenzol agar, which latter can not reach the duodenum. The two beads are put in a gelatine capsule and given to the patient. Six hours later the beads are withdrawn and inspected. This should be done at a time when there is presumably free HCl present in the stomach, as for instance, one hour after Ewald's test breakfast. If the two beads are in the stomach, both will be red. If one was in the duodenum and one in the stomach the duodenal bead will be yellow and the other red. If we find that both are red, or that the lower one is red, we may suspect that there exists some obstruction at the pylorus to the passage of the beads from the stomach into the duodenum.

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[1] A New Method of Estimating the Permeability of the Pylorus and an Attempt at Testing the Pancreatic Function Directly, New York Med. Jour., June 20, 1908.

As soon as I noticed that we could enter the duodenum with the thread and the bead, I thought that it would be better to have a capsule or little bucket instead of the bead, as it could bring us the duodenal fluid itself.

That gave me the idea of the duodenal bucket. If it is found that the bucket is filled with contents of an alkaline reaction containing pancreatic ferments, we know that we have been in the duodenum. Roentgen-rays confirmed that the duodenal bucket really was in the duodenum. This was described by me[1] in an article entitled "A New Method of Estimating the Permeability of the Pylorus and an Attempt at Testing the Pancreatic Function Directly."

As soon as I saw that we could enter the duodenum with this instrument I had the desire to do something more for the pylorus and duodenum. I[2] constructed an instrument that could be pushed over the thread. This was a thin catheter, by means of which I obtained duodenal juice. The thread served as a guide to enter the duodenum. Not only can we aspirate the contents of the duodenum by the introduction of a catheter, but by means of another specially constructed instrument can we dilate the pylorus.

Taking into consideration that the introduction of this catheter instrument was not very agreeable to the patient, and that it could not enter deep into the duodenum, I soon afterward had the idea of employing simply a small rubber tube ending in a perforated metal capsule, which may be given instead of the bucket, letting the stomach do the work of introducing it into the duodenum. This is the main principle—instead of pushing an instrument—to let the stomach carry out the work. This principle was of the greatest value. That led me to the construction of the duodenal pump, so called because I first used it to aspirate the duodenal contents. It consists of a moderately thin rubber tube, at the end of which is attached a perforated olive. If the rubber tube is too thin, it is difficult to obtain the fluid; if too thick, it is too clumsy and not so pleasant for the patient.

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[1] Loc. cit.

[2] Max Einhorn: A New Method of Catheterizing the Pylorus and Duodenum, Medical Record, October 9, 1909.

This method was demonstrated by me on a patient at the meeting of the Clinical Society of the Physicians of the German (now called Lenox Hill) Hospital of New York, on November 11, 1909. There were about fifty practitioners present.

Very shortly after this demonstration M. Gross[1] of New York described another duodenal tube, which is similar to mine. He, however, uses another procedure of reaching the duodenum, employing different positions, in order to make the tube pass the pylorus. According to my experience the position of the patient does not exert much influence upon the passage of the tube into the duodenum. The latter depends entirely upon gastric peristalsis and patency of the pylorus.

Palefski[2] modified the duodenal tube, employing at its end a heavier capsule which is ball shaped.

[1] M. Gross: A Duodenal Tube, N. Y. Medical Journal, Jan. 8, 1910.

[2] I. O. Palefski: The Examination of the Gastroduodenal Tract, Interstate Med. Journal, 1914, p. 977.

Rehfuss[1] of Philadelphia, likewise made the capsule end heavier and arranged for window-shaped openings in it. Both modifications are believed by their originators to facilitate the entrance of the tube into the duodenum, which I hardly think they accomplish. Moreover, there are disadvantages in these modifications. The heavy capsule exerts undue pressure on the gastric or duodenal mucosa and the big openings allow coarser particles of food to enter the tube, which are apt to clog it.

Jutte[2] was among the first to use the duodenal tube for the instillation of water. He employs a tube with a solid metal end piece, above which are situated numerous small openings. This again does not appear advantageous, for the necessarily small openings in the fine thin tube become easily clogged up with mucus, and fail to let the water pass.

DESCRIPTION OF THE INSTRUMENTS USED FOR OBTAINING THE DUODENAL CONTENTS DIRECTLY

The Duodenal Bucket.[3,4]—The duodenal bucket consists of a small gold capsule (*a*) 2 cm. long and 23 mm. in circumference; (*b*) 1 cm. long and 23 mm. in circumference; (*c*) 1 cm. long and 18 mm. in circumference, to which is attached a long string (almost one meter) of braided silk (English No. 5) with a rubber band at the end.

The duodenal bucket I originally used to test the permeability of the pylorus and to obtain pancreatic secretion is employed also for the thread or string test,[1,2,3] by means of which the presence and location of ulcers along the upper digestive tract can be ascertained.

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[1] M. E. Rehfuss: A Modified Gastroduodenal Tube, N. Y. Med. Journal, Aug. 22, 1914, p. 374.

[2] M. E. Jutte: Transduodenal Lavage, N. Y. Med. Journal, March 16, 1912, p. 542.

[3] M. Einhorn: N. Y. Med. Journal; Jan. 20, 1908.

[4] M. Einhorn: International Jour. of Surgery, Jan., 1912.

The duodenal bucket is used for the following purposes:

1. To determine the permeability of the pylorus.
2. To obtain the duodenal contents for examination.
3. To localize ulcerations along the path of the thread (viz., esophagus, lesser curvature, pylorus, duodenum).

Method of Use.—The patient swallows the duodenal bucket in the evening, late after supper, with a glassful of water. The end of the thread is attached to the nightgown in such a manner that a length of 30 to 32 inches from the lips can enter the digestive tract, and the bucket is allowed to travel by itself over night while the patient is asleep. In the morning before breakfast it is slowly and carefully withdrawn by the physician. When the larynx is reached a resistance will be felt. This must not be overcome by forcible pulling, but the patient must be told to swallow and during the act of deglutition the bucket may be easily withdrawn.

Before removing the bucket a knot must be made at the teeth in order to determine the length of the thread in the digestive tract. It is important that the patient should take no substances at supper that might cause a stain on the white silk thread resembling blood (viz., coffee, jellies, claret, etc.).

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[1] M. Einhorn: A New Method of Recognizing Ulcers of the Upper Digestive Tract and Localizing Them, Med. Record, April 3, 1909.

[2] M. Einhorn: Further Experiences with the Thread Test for the Recognition of Ulcers of the Upper Digestive Tract, Internat. Jour. of Surgery, Nov., 1909.

[3] M. Einhorn: The Importance of the Thread Impregnation Test for the Recognition of Ulcers of the Upper Digestive Tract, Med. Record, March 18, 1911.

After withdrawal of the bucket the thread is immediately and carefully examined for (1) blood spots, (2) bile stains. Then the contents of the bucket are aspirated by means of a small pipette and likewise examined.

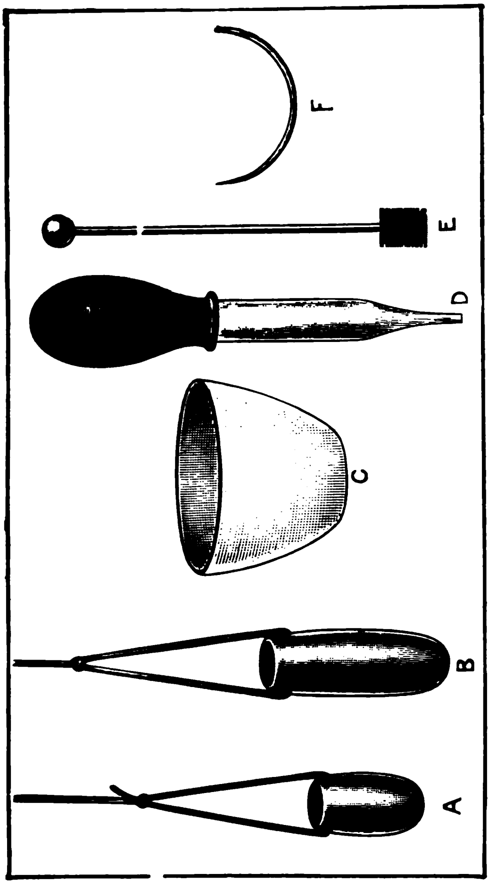

FIG. 1.—The duodenal bucket and its accessories. A, small size; B, larger size; C, porcelain dish; D, aspirating pipette; E, brush; F, needle.

The distance of the blood spots from the knot at the teeth will give the localization of the ulcer. If the end, say the lower four to eight inches, are stained a golden yellow, it will show that the bucket had passed the pylorus, provided that the length of the thread in the digestive tract remaining white exceeds 22 inches, and that therefore the pylorus is permeable. (The distance from the teeth to the pylorus is on an average 22 inches.)

If the bucket has been in the duodenum, the contents are usually golden yellow, viscid, and slightly alkaline. Sometimes, however, they may be acid and whitish, especially if the bucket has been only just beyond the pylorus.

The thread test appears to be of importance not only in the recognition of the position of an ulcer, but also as a criterion of the efficacy of our procedures, especially whether a cure has been accomplished or not. In those cases in which perfect healing of the ulcer has taken place the test becomes negative.

In the diagnosis of cancer of the stomach the thread test is of value in aiding us to recognize a suspected neoplasm before it is yet palpable. This is particularly the case in malignant affections of the cardia and the pylorus.

In several cases of neoplasm of the pylorus the bucket did not pass beyond the pylorus and came back filled with a brownish fluid of a fetid odor, the thread being stained brownish for quite a distance from the bucket.

The Aspirating Duodenal Catheter.[1]—Although there is no doubt that with the duodenal bucket we can gather the secretion of the duodenum, yet it appears to be of importance to possess a method which would enable us to pass a bougie or catheter into this canal, in order to allow this important short stretch of bowel to be examined instrumentally. This can indeed be done by pushing forward a catheter upon the thread holding the duodenal bucket. The catheter is perforated twice at its lower end; the end of the thread is pulled through these holes and the catheter is pushed along the thread into the pharynx, esophagus, stomach, pylorus, and then the duodenum. In using this method we must not proceed too quickly or use force, but must feel our way slowly.

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[1] A New Method of Catheterizing the Pylorus and Duodenum, Med. Record, Oct. 9, 1909.

The principle of the method can easily be demonstrated on a vessel with two openings representing the stomach.

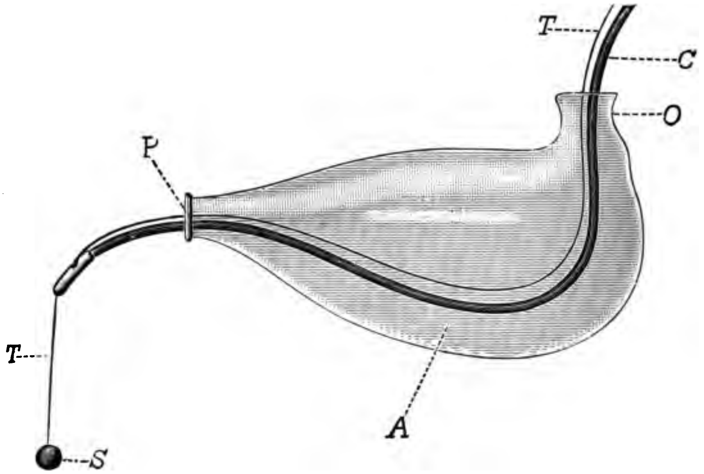

FIG. 2.—A, glass vessel with two openings, P and O; S, shot; T, thread; C, catheter.

If you tie a buckshot to a thread and drop it through opening O, and then allow it to emerge at P, by inclining the vessel, holding the thread tight at O, we can pass a whalebone perforated at its lower end over the thread and then shoving it along the thread through O and P (Fig. 2) without changing the position of the vessel. If, however, we should try to shove the whalebone, alone, without the guidance of the thread through O, it would touch the bot-

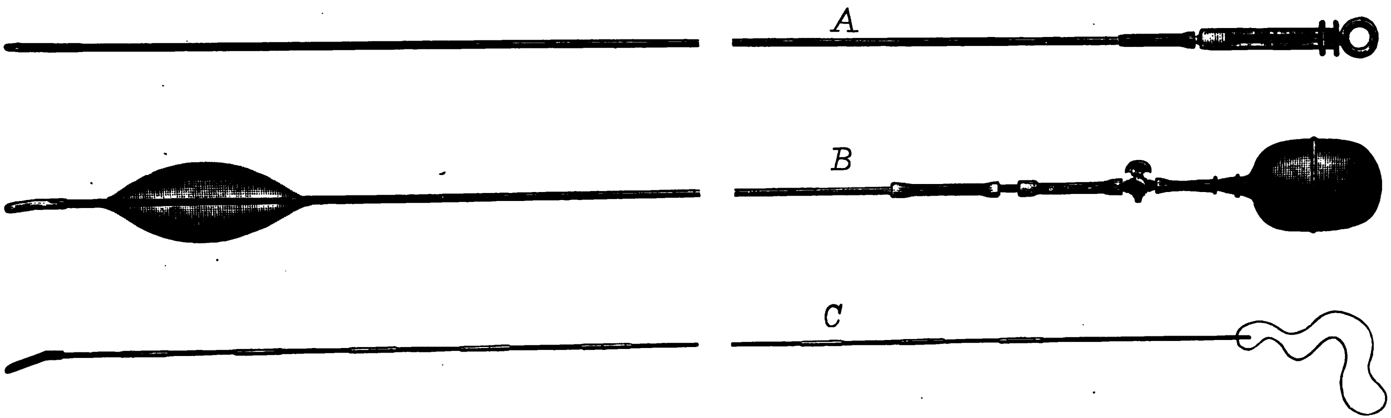

FIG. 3.—Instruments for the exploration of pylorus and duodenum. A, aspirating catheter; B, inflatable catheter; C, whalebone bougie with metal end and lead paper wrappings.

tom of the vessel at once and could never reach P. The conditions in the stomach are similar. O represents the cardiac part of the esophagus, P the pylorus. When the duodenal bucket is in the duodenum we can utilize the thread as a guide and introduce over it a flexible instrument (catheter, bougie, etc.) into the pylorus and duodenum.

According to this principle I have succeeded in several patients to push a catheter through the pylorus and then by means of the syringe to aspirate the duodenal contents (Fig. 3, a). Furthermore, I have passed through the pylorus a catheter the lower part of which carries an inflatable balloon (Fig. 3, b), and after inflation felt on withdrawal plainly the resistance offered by the pylorus. In order to be absolutely sure, however, that the instrument reached the duodenum, I introduced a metal-tipped whalebone bougie, that was covered with tinfoil at frequent intervals, and then had *X*-ray pictures made with and without bismuth.[1] They demonstrated the position of the duodenal bucket as well as the bougie very plainly. The bucket was in the small intestine (the length of the thread being 83 cm.), and the metal piece of the bougie in the duodenum. There can not, therefore, be the slightest doubt that we can reach the pylorus and duodenum instrumentally.

This opened new avenues for the recognition and treatment of affections of the pylorus and duodenum.

The Duodenal Pump or Tube.[2]—The importance of testing the duodenal contents is evidently great. Here we find the most important secretions for digestion. The duodenal bucket occasionally brings up the desired juice, but the same may be mixed with stomach contents, and its quantity is too small to make more detailed examinations.

---

[1] All the instruments for the exploration of the pylorus have been made for me by Tiemann & Co., New York.

[2] Max Einhorn: A Practical Method of Obtaining the Duodenal Contents in Man, Medical Record, Jan. 15, 1910.

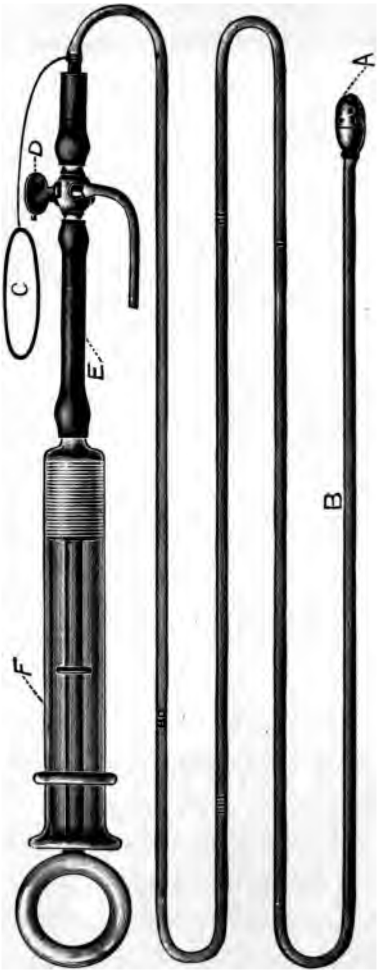

FIG. 4.—The duodenal pump. A, metal capsule, lower half provided with numerous holes; the upper half communicating with tube; B I, II, II, marks of I = 40, II = 56, III = 70 cm. from capsule; C, rubber band with silk attached to end of tubing, which can be placed over the ear of patient; F, aspirating syringe; E, collapsible connecting tube; D, three-way stopcock.

The aspiration catheter which I introduced later over the thread of the duodenal bucket beyond the pylorus, into the duodenum, has also not quite succeeded in solving this problem. The introduction of the catheter is somewhat difficult, and it can be introduced only into the pylorus and the beginning of the duodenum, but not into the lower portions of the duodenum.

I have therefore constructed a new instrument[1] for this purpose. It consists of a small metal capsule (14 mm. long and 23 mm. in circumference), which is perforated and can be unscrewed. This communicates with a long, thin rubber tube (8 mm. circumference and 1 meter long), and is marked at 40 (I, cardia), 56 (II, pylorus), 70 (III), and 80 cm. distance from the capsule. At its end is a tip, to which a syringe can be attached (Fig. 4). This small instrument looks almost like the deglutible electrode. It can be used for aspirating stomach or duodenal contents, and might aptly be called a "duodenal pump" or "digestive juice aspirator."

Mode of Procedure.—The capsule of the duodenal pump, as well as the lower part of the rubber tube, are moistened with warm water and put into the pharynx of the patient. Then the latter drinks some water, and the instrument thus soon passes into the stomach. To be certain that the capsule did not get stuck in the esophagus, it is well to have the patient shake his abdomen and to aspirate a syringeful of chyme. This can easily be identified as gastric contents. Now we pass a syringeful of water and then one of air through the instrument. The rubber tube is then clamped off and left alone for about one hour. The patient is told not to close his mouth too tightly, so that the tube is not retarded in its wanderings. The patient must also avoid intentional swallowing of the tube. Through the peristalsis of the stomach the capsule is pushed on further, and usually passes through the pylorus into the duodenum and later into the beginning of the small intestine. It is best to have the patient read some light literature, in order to divert his attention. After one hour we examine how far the capsule has progressed; if sign III is near the lips (70 cm.) or inside the mouth, we try to aspirate. If the capsule is in the duodenum, we generally obtain a clear, golden yellow or watery liquid of alkaline reaction and somewhat viscid consistency. If, however, we are in the stomach, we obtain an acid liquid resembling the one first removed. This can, of course, occur if the

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[1] Demonstrated before the Clinical Society of the German Hospital and Dispensary, November 11, 1909.

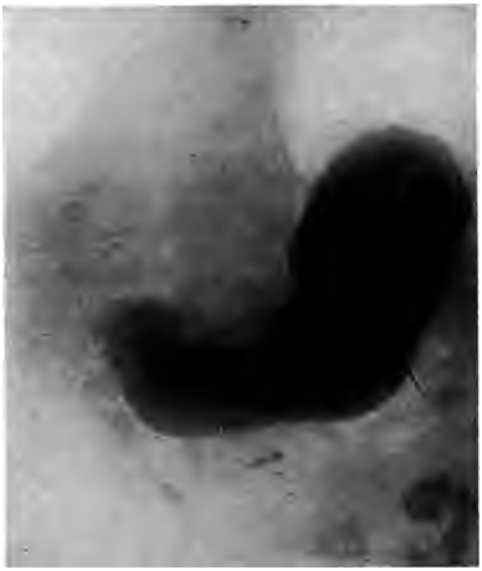

FIG. 5.—*X*-ray of M. F. with barium in the stomach. The duodenal tube (filled with bismuth) is visible in the duodenum, the capsule lying in the descending portion of the duodenum. (*Radiogram taken by Dr. Wm. Stewart.*)

tube lies in the stomach in a coiled manner. Should the latter be the case, we must partly withdraw the tube, after putting water and air through it, up to the mark II (56 cm.). The tube is then again clamped off, and after one-half to one hour the procedure is repeated. We generally succeed in nearly all cases (of course, not in such where there is pyloric stenosis) to obtain duodenal contents. After having obtained the desired contents, the tube is clamped and slowly withdrawn. When the beginning of the œsophagus is reached the patient is told to swallow, and during this act the capsule is withdrawn.

The same instrument can, of course, also be used to study the act of gastric secretion during the entire period of stomach digestion from beginning to end. In this case the tube is fastened so that it can not go beyond mark II; the capsule thus remains all the time in the stomach Every half-hour or so the contents may be aspirated and comparisons of the acidity, etc., made, and thus the secretion of the stomach may be studied.

In examining the contents of the duodenum it is of importance to have evidence when we are in the stomach and when we are in the duodenum. I therefore wish to call attention to the following points:

1. If the capsule is in the stomach and we aspirate, the syringe quickly fills with fluid or air, provided that the holes are not clogged by coarse food. The heavier rubber tube attached to the syringe does not collapse, as this organ is always filled with either air or liquid. If, however, the capsule is in the duodenum, one finds that the connecting rubber tube will collapse on rapid aspiration. This is caused by a vacuum forming, owing to the fact that there

is not much air or liquid in the duodenum and because the walls of the latter are in close apposition to the capsule. (We find the same condition if the capsule is in the esophagus.) After waiting a short while and after slowly trying aspiration, fluid enters the syringe. If we find a larger supply of bile and pancreatic juice, it appears a little quicker, but always slower than from the stomach.

2. If the capsule is in the stomach and air is forced through, the patient feels the entrance of the air very plainly and can localize where it occurred. If the capsule is in the duodenum or jejunum, the patient does not usually feel the entrance of air.

3. *The Milk Test.*—If we give patient two or three swallows of milk (provided, of course, that no milk had been previously taken), and then aspirate with the capsule in the duodenum, we obtain pure duodenal contents (golden yellow or clear as water) without any admixture of milk. If, however, the capsule is in the stomach, the milk appears at once. This milk test can be made still more reliable if, after aspiration of clear duodenal contents free from milk, we withdraw the tube up to mark II and a little further, and on renewed aspiration obtain the fluid from the stomach, containing unchanged or curdled milk.

4. The *X*-rays show the position of the capsule in the stomach or duodenum very plainly. A good apparatus shows not only the capsule, but also the course of the tube (Fig. 5).[1]

Preparation of the Patient for the Purpose of Duodenal Examination.—It is best that the patient should take only fluid food on the day of examination. In most cases I have had him take a cup of tea and sugar without milk half an hour before the examination.

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[1] I am indebted to Dr. W. H. Stewart for the excellent *X*-ray photograph.

Lately I have used clear beef bouillon (one bouillon cube of Armour & Co. to a cup of hot water) for the same purpose.

A smaller duodenal tube can be used for the examination of infants. In 1910 I have made some investigations regarding this point at Dr. Louis Fischer's ward of the Sydenham Hospital. In one to two hours the duodenal contents of several infants (3–6 months old) had been obtained and examined.

Hess[1] made use of the ordinary soft rubber Nélaton catheter (15 F); which is employed so frequently in infants and in adults for the purpose of lavage and feeding. Hess found that this simple instrument could be passed readily from the stomach into the duodenum, simply by pushing it forward.

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[1] A. F. Hess: The Use of a Simple Duodenal Catheter in the Diagnosis and Treatment of Certain Cases of Vomiting in Infants, American Journal of Diseases of Children, March, 1912, p. 133.

CHAPTER II

THE DUODENAL CONTENTS

The duodenal contents will naturally vary in their composition depending upon the different ingredients present. Thus, we may have pure duodenal secretion, free from any other admixture, or the latter in combination with either pancreatic juice or bile or both, without any chyme; ultimately either of the above juices alone or in combination, mixed with either pure gastric juice or chyme (gastric secretion and nutritive material).

A complete study of the duodenal contents should by right comprise an examination of each of the above-named variations. For the present, however, the entire field is new and the different factors are not yet fully known.

For practical purposes the examination of the duodenal contents is undertaken in the fasting condition of the patient and also ½-1 hour after a test meal of either tea and sugar or still better beef bouillon, as mentioned above.

The examination of the fasting contents will be given preference, whenever a thorough study of the bile appears of importance, while the test meal examination will be more advantageous if the pancreatic function is to be investigated.

ANALYSIS OF THE DUODENAL CONTENTS

The duodenal contents are usually alkaline (although never red with phenolphthalein). As indicators of a qualitative or quantitative test litmus or methyl orange are generally used. A $1/10$ standard solution of HCl is employed for determining the degree of alkalinity, and a $1/10$ standard solution of NaOH to ascertain the degree of acidity, whenever such is encountered. The figure of alkalinity or acidity is given in the number of c.c. of the $1/10$ standard solution required for neutralizing one hundred c.c. of the examined fluid.

The duodenal contents should always be subjected to a minute inspection, immediately after their withdrawal, for changes of color and the physical state of the fluid are apt to occur within a short period of time (1–3 hours).

In the fasting condition or after the ingestion of clear fluids the duodenal contents usually look yellow (bile) and clear. They are viscid and form a foam upon shaking. The specific gravity varies from 1004–1006.

Qualitative and Quantitative Tests for the Pancreatic Ferments.—At first I applied the qualitative tests in vogue, which were as follows:

1. To test for steapsin take one drop of neutral milk, two drops of water, two to three drops of duodenal contents (neutralized if the reaction is acid), and a small piece of litmus agar. Mix all these ingredients and keep them in a miniature test tube at blood temperature. If steapsin is present the agar piece will be red in 20–30 minutes, owing to the development of fatty acids.

2. For the demonstration of trypsin use a small piece of the white of a hard boiled egg, which is placed in the fluid to be examined (if acid, it is first neutralized) and kept a few hours at blood temperature. The piece of egg albumen disappears in the presence of trypsin.

3. Amylopsin. For testing for the presence of diastase we make use of a boiled starch solution or starch paper. We mix the duodenal contents with the starch solution (in equal parts), or insert a strip of starch test paper and leave it at blood temperature. After half to one hour we look whether the fluid or the test paper contains starch by adding a weak iodine solution. In the presence of starch we obtain a blue color, in the presence of erythrodextrin a red color, otherwise only a trace of brown from the iodine.

Quantitative Methods of Determining the Pancreatic Ferments.—In conjunction with Rosenbloom[1] I have employed the following quantitative method for determining the amounts of ferments in the contents.

Amylase.[2]—To 10 c.c. of a 1 per cent. solution of freshly prepared starch paste was added 1 c.c. of the juice and 1 c.c. of toluol, and the mixture allowed to digest at 40 C. until duplicates showed no longer blue with iodin solution. At this point the bottles containing the digestive mixture were placed in boiling water to stop digestion at the same moment. The contents were then made up to 50 c.c. and run in from a burette into boiling Fehling's solution, acetic acid and potassium ferrocyanid being used to determine the end point. The number of cubic centimeters of the digestive mixture required to reduce 10 c.c. Fehling's solution 0.05 gm. dextrose or its equivalent of maltose was ascertained. When the amount of sugar in the digestive mixture was less than that required to reduce the copper, a standard dextrose solution was added.

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[1] Max Einhorn and Jacob Rosenbloom: A Study of the Duodenal Contents in Man, Archives of Internal Medicine, Dec., 1910, p. 666.

[2] Amylase values are given in the number of cubic centimeters of the digestive mixture, which, when made up to 50 c.c., were equivalent to 0.05 gm. of glucose.

Lipase.[1]—One c.c. of the juice, 10 c.c. of water, 1 c.c. of neutral ethyl butyrate and 1 c.c. toluol were placed in a bottle and allowed to digest at 40 C. After twenty-four hours 1/20 normal solution of sodium hydroxid in water, with phenolphthalein as an indicator, was used to determine the amount of acidity developed. From this amount was subtracted the amount of acidity, if any, in the duplicates containing 1 c.c. of juice plus 10 c.c. water and 1 c.c. toluol. Each digestive mixture was shaken ten times during the twenty-four hours.

Alkali-protease[2] (*Trypsin*).—Preparation of Gelatin Tubes: Ten gm. of gelatin were dissolved in 100 c.c. of a 1 per cent. solution of sodium fluorid and colored with methyl violet. This solution was drawn up into capillary tubing 1 mm. in diameter, and the tubing quickly placed under cold water to congeal the gelatin solution. The tubing was then cut up into lengths of 2 cm.

Determination of Alkali-protease: Ten c.c. of the juice were placed in a small bottle, closed with a perforated cork through which the gelatin tubes could be inserted. The digestions were kept at room temperature for forty-eight hours to determine the alkali-protease. One c.c. of toluol was added to each digestive mixture and enough 0.2 per cent. sodium carbonate solution to make the mixture alkaline in reaction.

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[1] Lipase values are given in the amount of 1/20 normal solution of sodium hydroxid necessary to neutralize the acidity developed.

[2] Alkali-protease (trypsin) values are given in the number of millimeters of gelatin digested.

Agar Tubes for the Estimation of the Pancreatic Ferments.[1, 2]—The above methods for determining the pancreatic ferments are somewhat complicated. It has appeared to me that if the tests were simpler the examination of the pancreatic function would be more often undertaken by the clinician, and in this way be of more assistance in diagnosis.

My aim was at first to make use of Mett's tubes for the determination of the trypsin ferment and to arrange for similar tests for the remaining ferments. Mett's tubes proved unsatisfactory for this kind of work, the albumin frequently failing to disappear, notwithstanding the presence of trypsin. Fermi's gelatin tubes which I used in conjuction with Rosenbloom are much more appropriate, the only disadvantage being that they have to be kept at the temperature of the room. In as far as the tests for steapsin and amylopsin are better made at blood temperature, it requires separate specimens, some to be kept at the room temperature and others at blood temperature. In dealing with small quantities of secretion, as is often the case, this is a drawback.

For amylopsin, starch tubes have been used by Wohlgemuth. My attempts to employ the same kind of tubes for the amylopsin tests failed utterly. If we took a high percentage of starch, 8 to 10 per cent., in the tubes, it would not liquefy, but would remain as a solid mass in the tube, while on using a lower percentage (5 per cent.) it would flow out completely without the presence of the amylopsin.

These tubes not working satisfactorily, it occurred to

[1] M. Einhorn: Medical Record, Oct. 12, 1910.

[2] M. Einhorn: Recent Studies of Pancreatic Secretion, Medical Record, June 12, 1915.

me to use test substances in agar vehicles. The principle is the following: Agar tubes—mixed with albumin, starch, fat—allow the ferment action to take place in them by osmosis. If the test substances added are colored with indicators, which undergo a change when acted upon, it is easy to ascertain the presence of the ferments, and also to estimate their approximate amount by the volume of tube changed given in mm.

The manner of making the different kinds of tubes is as follows:

I. *Starch Tubes.*—Agar powder, 2.5; starch, 5.0; distilled water, up to 100.0. Rub the starch and agar in a mortar with sufficient water to make a smooth paste, then add the balance of the water. This mixture is put into a flask and heated to the boiling point. It is then drawn by suction into a capillary glass tube (inside diameter, 1.5 mm.) which has previously been warmed in the flame. The tube and contents are allowed to cool and are then cut into 3-cm. lengths. These are sealed at each end with melted paraffin.

II. *Olive Oil Tubes.*—Olive oil, 25.0; agar powder, 2.0; aqueous solution of nile-blue sulphate (1 :2000), sufficient to make 100.0.

Rub the olive oil and agar together, add sufficient water to make a thin paste, then add the nile-blue-sulphate solution to make the balance of 100 c.c. Then proceed the same as with the starch tubes.

III. *Hemoglobin Tubes.*[1]—Hemoglobin powder, 1.0; agar powder, 2.5; distilled water, sufficient to make 100.0.

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[1] I am indebted to Mr. Herbert Abraham, chemist of the Standard Paint Co., for suggesting the use of hemoglobin for this purpose.

Rub the hemoglobin with about 10 c.c. of water until it is smooth, add the agar powder and the balance of the water; then proceed in the same manner as with the starch tubes.

The agar tubes[1] are best kept on ice until used. They retain their efficiency for a month or six weeks, then they begin to deteriorate. They become dry and are apt to give wrong results.

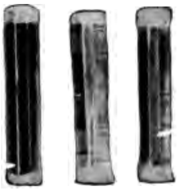

FIG. 6

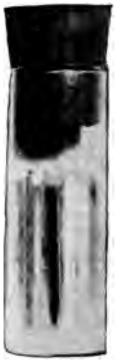

FIG. 7

FIG. 6.—The agar tubes sealed with paraffin.

FIG. 7.—The agar tubes have been put in the bottle containing a small amount of duodenal contents. The specimen is ready for the digestion test in the oven.

Mode of Procedure.—Take one each of the starch, oil, and hemoglobin tubes,[2] scrape off the paraffin at both ends, and put them vertically into a bottle containing the duodenal secretion (Figs. 6 and 7). Add a few drops of toluol and keep the bottle at blood temperature for sixteen to twenty-four hours. The examination is made in the following way: The agar tubes are taken out from the bottle, wiped off, and inspected. The hemoglobin tube shows a change of appearance (due to the action of the trypsin) and a clearing up of the end part, becoming more or less transparent; the oil tube manifests a bluish appearance (the steapsin ferment splits the oil into fatty acids producing this color) at the end. The lengths of transparency in the hemoglobin tube and of bluish color in the oil tube are measured and stated in millimeters (Fig. 8). The starch tube is further examined by pushing out the agar column and dipping it into a weak iodin solution. The portion of the starch column remaining colorless indicates the part changed (by the amylopsin ferment) into sugar and is given in millimeter lengths.

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[1] The agar tubes for testing the pancreatic ferments may be obtained at Eimer & Amend, 205 Third Ave., New York City.

[2] If the tubes are not fresh, it is best to keep them in water for about 5 minutes (after the paraffin has been scraped off).

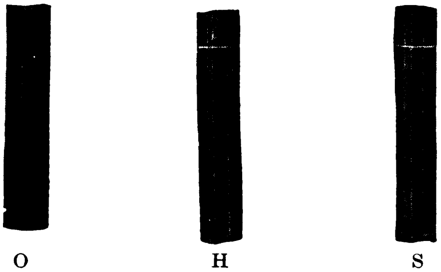

Fig. 8.—The agar tubes after having been subjected to the action of pancreatic juice. O, olive oil; H, hemoglobin; S, starch; the latter has been dipped into a weak solution of iodin.

Thus, the hemoglobin serves to gauge the trypsin, the olive oil the steapsin, and the starch the amylopsin ferments. As a thermostat I have recently used Freas' electric oven, which is very convenient indeed.

The Rennet Ferment.—Besides the above described three ferments for the digestion of albuminates, carbohydrates, and fats the pancreatic secretion contains a milk-coagulating ferment.

In the duodenal contents a similar ferment is found. The question arises, is this rennet ferment due to the pancreas or is it perhaps the rennet ferment of the stomach? In order to decide this point it was necessary to look for some points of differentiation between these two ferments, viz., the gastric and pancreatic rennets.

I[1] accidentally observed that boiled milk did not curdle with the duodenal contents. I therefore investigated this point. The experiments with gastric and pancreatic secretions, mixed with boiled and unboiled milk (1 drop of either secretion to 1 c.c. of milk), showed that the gastric juice coagulates milk, without any difference whether it be raw or boiled, while the pancreatic secretion (as found in the duodenum) curdles raw milk and not boiled milk, the latter remaining fluid for four to six hours. This clearly shows that the rennet ferment, found in the duodenum, belongs to the pancreas and is different from the gastric rennet.

There exist two more points of differentiation: (1) Gastric rennet curdles milk in from five to ten minutes, while the pancreatic rennet requires from twenty to sixty minutes to do this; (2) the gastric juice, made alkaline to phenolphthalein, loses its coagulating faculty for milk; the duodenal contents, made alkaline to phenolphthalein, retain their ability of curdling milk.

One drop of pancreatic secretion, as found in the duodenum, mixed with 1 c.c. of milk and left at blood temperature for twenty to twenty-four hours, very often shows almost an entire disappearance of the white milky color, the fluid now being watery or slightly straw colored and transparent. At times there is a small coagulum left at the side of the tube. The amount of coagulum left depends probably on the amount of trypsin present. This would make it possible to use milk as a coarse test for the presence or absence of trypsin. Boiled and unboiled milk show a great difference in their action with the pancreatic secretion, with regard to the amount of coagulum left undissolved after twenty-four hours, boiled milk showing a coagulum sometimes ten times as large as unboiled milk. But this difference of boiled and unboiled milk with regard to its coagulum is also noticeable in its relation to the gastric juice (Fig. 9, A and B).

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[1] Max Einhorn: Recent Studies of Pancreatic Secretion, Med. Record, l. c.

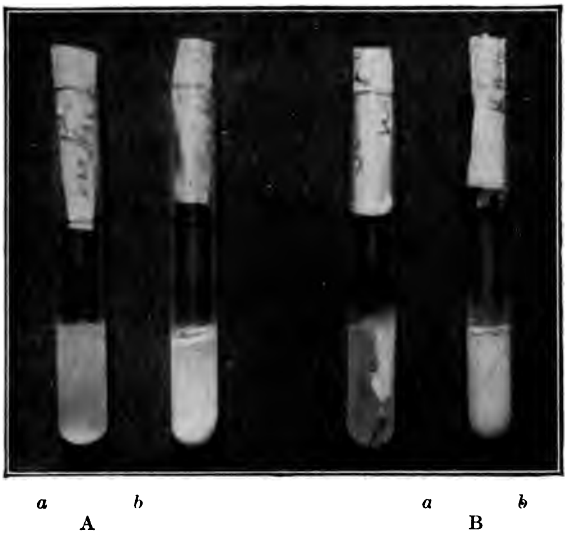

Fig. 9.—A, duodenal contents (patient S); B, gastric contents; each 1 part to 20 parts milk (*a*, raw, *b*, boiled), after 20 hours' digestion at blood temperature.

Fractional Examination of the Duodenal Contents.[1] Similar to the fractional examination of the gastric contents, a study of the duodenal contents at different intervals after a certain test meal can be undertaken.

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[1] Max Einhorn: The Fractional Examination of the Duodenal Contents, American Journal of the Med. Sciences, Dec., 1918.

An appropriate test meal is one cup of beef bouillon (one bouillon cube, usually, Armour & Co., to one cup of hot water). Examination of the duodenal contents is first done in the fasting condition, then one cup of bouillon is given by mouth and the duodenal contents aspirated every half hour for a period of two hours (fractional examination).

The mode of procedure is as follows: Patient is given the duodenal tube in the evening after a light supper. Attention should be paid to the length of tube which has entered the buccal cavity before retiring. Mark III of the tube should have reached the mouth; if not, the patient is given milk or water and the tube in this way made to go in beyond the III mark before going to sleep. In patients who sleep restlessly it is advisable to attach the tube, lying outside the mouth, with a piece of adhesive plaster to the cheek, in order to avoid a pulling out of the instrument during the night by any inadvertent motion. In the early morning the capsule end of the tube has usually reached the duodenum and the desired examination can be performed.

The writer has examined the duodenal contents of 32 people with the fractional method. Two of them were apparently normal individuals, while the rest were afflicted with different ailments (gastrointestinal diseases and glycophilia (Meyer)).

In the normal cases one revealed (in the fasting condition) an alkalinity of the duodenal contents of 30, while ½ hour after the bouillon test meal it was 10, then it rose to 25, 25 and ultimately to 30. The ferments, likewise, were strongest in the fasting condition, while they were weakest ½ hour after the test meal, to increase in strength later on. The other one showed an alkalinity in the fasting condition of 20; ½ hour after the test meal it was the same. The ferments in the fasting condition were weaker than ½ hour after the bouillon; 1 hour after the test meal they were strongest, while later the steapsin ferment grew weaker.

In the pathological cases the degree of alkalinity of the duodenal contents appeared to be dependent to a certain extent upon the state of gastric secretion, cases of hyperchlorhydria showing a lowered alkalinity while cases of subacidity manifested an increased alkalinity. This rule, however, does not hold good all the time. There seem to be other factors, besides gastric secretion, which play a part in regulating the degree of alkalinity of the duodenal contents. Chief among these are the pancreatic and duodenal juices and the bile. Each one of these is liable to have its own peculiarities and show alterations in disease.

The following types of alkalinity curves can be easily discerned.

Type I. Decrease of the alkalinity during the first half hour after the bouillon test meal, then a steady increase.

Type II. Increase of alkalinity between ½ and 1 hour after the bouillon, then slight decrease.

Type III. Increase of alkalinity during the first half hour after the bouillon, then slight decrease up to 1 hour, then again increase to 1½ hours, thereupon again a decrease.

Type IV. There is first a steady increase of alkalinity up to 1½ hours after the bouillon test meal, then an abrupt descent of the curve, so that at 2 hours after the bouillon the contents are acid instead of alkaline.

Of the three ferments each shows its individual peculiarities, and the strength of one ferment cannot be gauged by that of the other. It is possible to ascertain the strength of each ferment at the different periods after the test meal and express it in the form of a curve, each one having its own curve.

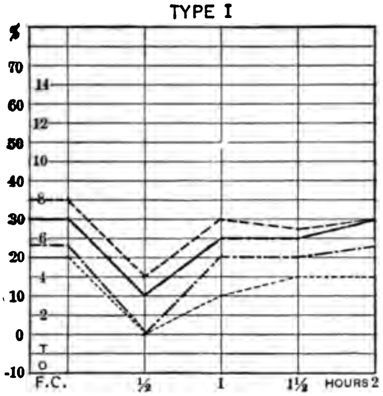

Fig. 10.

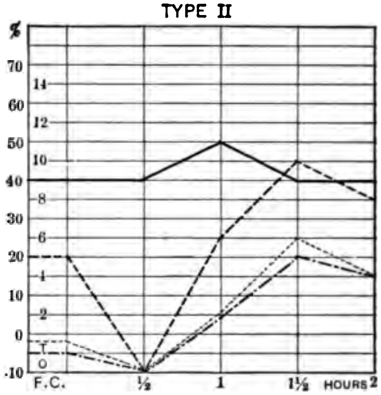

Fig. 11.

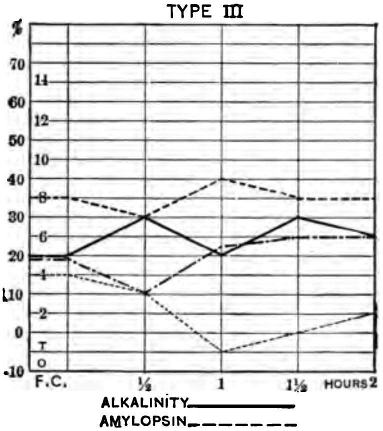

Fig. 12.

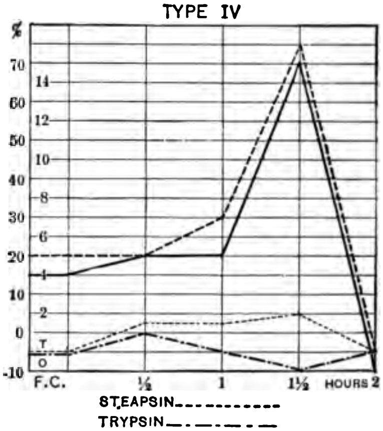

Fig. 13.

Figs. 10–13.—The four different types of alkalinity curves of the duodenal contents as encountered in actual findings (with the ferments subjoined).[1]

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[1] Max Einhorn: l. c.

CHAPTER III

THE DIAGNOSTIC IMPORT OF THE DUODENAL TUBE

In the preceding chapter the methods of obtaining and analyzing the duodenal contents have been described. Their physiological appearance and qualities have, likewise, been stated.

A study of the deviations constantly or frequently found in pathological states will help to recognize the latter and thus be of diagnostic aid.

Thus far the above devices have proven of practical importance in the following conditions, which will be described in natural sequence.

Stomach and Pylorus.—(*a*) A diagnosis of ulcer of the stomach, pylorus or duodenum can frequently be made by the duodenal bucket and the string test. The bucket under these conditions contains a bile-stained fluid, the string next to the bucket is golden yellow, and there is on the string a localized blood stain at some distance from the lips (from 15–24 inches); if the stain is situated between 15–16 inches it indicates a cardiac, between 16–21 a lesser curvature, between 21–22 pyloric, 22–24 duodenal ulcer.

(*b*) The bucket returning with bile, and the string being golden yellow below 23 inches from the lips, indicates permeability of the pylorus for the bucket (size 23 French).

(*c*) The bucket having sojourned in the digestive tract for 8–10 hours (over night) with a length of string, measuring from the lips more than 25 inches, without bile in the

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bucket or a yellow color of the string next to it, indicates pyloric stenosis (excepting in cases of jaundice). The latter is due either to a spasm of the orifice or to an organic stricture. To decide this the bucket test is repeated and atropin, gr. $1/120$ to $1/60$, is given at the same time. The bucket again returning without any traces of bile suggests the presence of an organic obstruction of the pylorus, while the presence of bile on the string below 23 inches favors the existence of a pylorospasm.

(*d*) The duodenal tube, likewise, can be utilized for the differentiation of these two conditions, namely: organic stenosis of the pylorus and pylorospasm. The duodenal tube with a length of 25 inches or more in the digestive tract, for over 10–12 hours, failing to pass the pylorus (as evidenced by the aspiration of characteristic gastric juice and no duodenal contents), indicates either spasmodic or organic closure of the pylorus. Under the administration of atropin the tube is allowed to stay 10–12 hours longer in the digestive tract, and withdrawal of contents is again tried during this period. Failure of obtaining real duodenal contents makes the presence of an organic stricture of the pylorus probable, while the successful aspiration of the duodenal secretions favors the diagnosis of a pylorospasm.

The Duodenum.—(*a*) Duodenal ulcer can occasionally be diagnosed by the presence of visible blood in the mildly aspirated—or still better in the syphonaged—fluid from the duodenum. A provision must be made that the gastric contents were free from blood.

(*b*) Acute and chronic catarrh of the duodenum.[1] Acute duodenitis leading usually to a congestion of the papilla of Vater and subsequent jaundice is easily recognized, Icterus, a swollen liver, absence of severe colicky pains, presence of dyspeptic symptoms (nausea, vomiting, fullness in the upper abdomen), and mild fever of short duration permit a probable diagnosis of acute duodenal catarrh. If, in addition, the duodenal contents show a great deal of mucus and bile, likewise mixed with mucus, the diagnosis becomes positive.

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[1] Max Einhorn: The Diagnosis of Chronic Duodenal Catarrh, Archives of Diagnosis, Oct.. 1910.

Chronic duodenal catarrh can be recognized with difficulty and at most a probable diagnosis can be arrived at.

The main features from which chronic duodenal catarrh can be recognized are as follows: Long history of digestive disturbances; epigastric pains about 2–3 hours after meals; slight hyperchlorhydria may be present or normal gastric secretion; flatulence; normal stools or diarrhea; tenderness on pressure in the epigastric region; presence of white mucus in the duodenal contents, interchanging with golden-yellow and clear bile without any mucous shreds.

Just as well as the gastric contents in conjunction with the subjective symptoms help establish the diagnosis of chronic gastric catarrh, in a similar manner the quality of the duodenal contents in combination with the morbid phenomena present aid us in establishing a diagnosis of chronic duodenitis.

Pancreas.—Up to within a few years it was generally believed that in pancreatic disease there would be a disturbance of its secretion in the sense that there should either be an absence of its ferments or a considerable diminution of them. A study[1] of the pancreatic juice in normal and pathological conditions has, however, shown that the pancreatic function—similar to the action of the stomach—is subject to manifold variations.

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[1] Max Einhorn: Recent Studies of Pancreatic Secretion, Med. Record, l. c.

The average figures for the normal amounts of pancreatic ferments are: amylopsin = 6 mm.; steapsin = 3.5; trypsin = 2.8; alkalinity = 15–40; rennet, present; quantity of flow by syphonage about 0.5–1 c.c. per minute.

In looking over the results obtained by the examinations of the pancreatic juice in pathological conditions there exists a noticeable independence between the three different ferments with regard to quantity in the same individual—*i.e.*, one ferment may be present in large amounts, while the other two may be present in small amounts or may be absent. The quantity of one ferment does not permit us to presume the amount of the two other ferments. It is, thus, necessary to test for each of the three ferments separately. This is accomplished in the most convenient way by means of the agar tubes.

The pancreatic secretion is subject to functional anomalies or deviations from the normal. The juice may contain an overabundance of ferments or too small an amount of them. Again, there may be hypersecretion or greatly diminished secretion. While in the gastric juice the functional activity is generally reckoned by the amount of hydrochloric acid present, there has as yet no definite substance of the pancreatic secretion been selected for this purpose. The trypsin ferment being the most important ingredient of the pancreatic juice, it was suggested to use it as a gauge for the functional activity of this gland. The following terms are advantageously used:

Eupancreatism = normal function; all three ferments present, trypsin showing the normal quantity (1 to 4 mm.).

Hyperpancreatism = increased activity; all three ferments present, trypsin existing in excess (above 4.0 mm.).

Hypopancreatism = diminished activity; the three ferments present, trypsin decreased (below 1 mm.).

Dyspancreatism = disturbed function; one or two of the three ferments are absent.

Heteropancreatism = varied function; the presence and amount of ferments showing no constancy, but variations every now and then.

In addition to these qualifications of the pancreatic juice which refer to its strength in ferment activity, we must discern the secretion as regards its quantity. There is then normal pancreatic secretion (euchylia), too much secretion or hyperchylia, and too little secretion or hypochylia pancreatica. Achylia pancreatica would mean there exists no pancreatic juice at all. Adolf Schmidt has used this term, but not exactly in the sense meant here. According to the terminology above stated, his cases would rather belong to the group: "dyspancreatism."

True pancreatic achylia—by this is not meant absence of pancreatic juice in the duodenum, due to the occlusion of the Wirsungian canal, for here secretion takes place but does not reach the intestine—does exist, but is very rare. It is encountered in the last stages of chronic pancreatitis and is, therefore, of grave significance.

There exist, therefore, functional disturbances of the pancreas in both directions (*i.e.*, too great activity and diminished work), which occur without and with organic lesions of this important gland.

(*a*) *Acute Pancreatitis.*—Severe dyspeptic symptoms with fever appearing abruptly and accompanied by great collapse, somewhat swollen liver, tense abdomen, and duodenal contents showing pronounced dyspancreatism, are sufficient to establish the diagnosis of acute pancreatitis.

(*b*) *Chronic Pancreatitis.*[1]—Cases of chronic pancreatitis may be subdivided into three classes:

1. Main symptom, diarrhea.
2. Main symptoms, gastralgia, constipation, weakness.
3. Main symptoms, diabetes mellitus, dyspepsia, weakness.

In Group 1, the following symptoms are prominent:

1. Severe profuse diarrhea, attended with the passage of large quantities of feces; plenty of undigested food particles are found in them, which are easily recognized macroscopically.
2. General weakness.
3. The digestive test capsule shows a great many of the test substances undigested.
4. Examination of the duodenal contents reveals either an entire absence or a very faulty pancreatic secretion, as, for instance, frequently one or two of the ferments, and at times even all of the three ferments, may be entirely absent.

In Groups 2 and 3 we find similar conditions, with the exception of the diarrheas, in place of which we find constipation. In Group 3 we find another important additional symptom; the presence of sugar in the urine.

As, according to Opie, in the majority (87 per cent.) of cases of diabetes we find an affection of the islands of

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[1] Max Einhorn: A Clinical Contribution to our Knowledge of Chronic Pancreatitis, Journal A. M. A., July 10, 1915, p. 149.

Langerhans in the pancreas, we can generally make the diagnosis of chronic pancreatitis in such cases without much difficulty. For it is clear that disease of these islands will lead to secondary involvement of the surrounding tissues of the pancreas. If, therefore, we find a diabetes with great weakness, loss of weight and dyspeptic symptoms, we must think of disease of the pancreas. If, in addition, examination of duodenal contents shows deficient pancreatic activity, the diagnosis of chronic pancreatitis is almost certain.

(c) *Cancer of the Pancreas.*—Dyspancreatism, or a constant lack of some of the pancreatic ferments in a patient whose other symptoms suggest the presence of a neoplasm, will help to establish a probable diagnosis of cancer of the pancreas. The same can be said of the frequent appearance of blood in the duodenal contents, provided a duodenal ulcer can be positively excluded.

Crohn,[1] who has done considerable work in this line, comes to the following conclusion:

1. Pancreatitis, particularly of the acute inflammatory or the chronic intra-acinar type, evidences itself by diminished ferments.
2. Severe abdominal disease may cause a functional hyposecretion of the pancreas.
3. Some cases of pancreatic disease, not associated with widespread destruction of the parenchyma, continue to furnish a secretion of normal enzyme activity.
4. A general gross proportion exists between the amount of surviving parenchyma and the ferment strength of the duodenal contents.

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[1] B. B. Crohn: Studies in Pancreatic Diseases, Archives of Internal Med., 1914, vol. 15, p. 581.

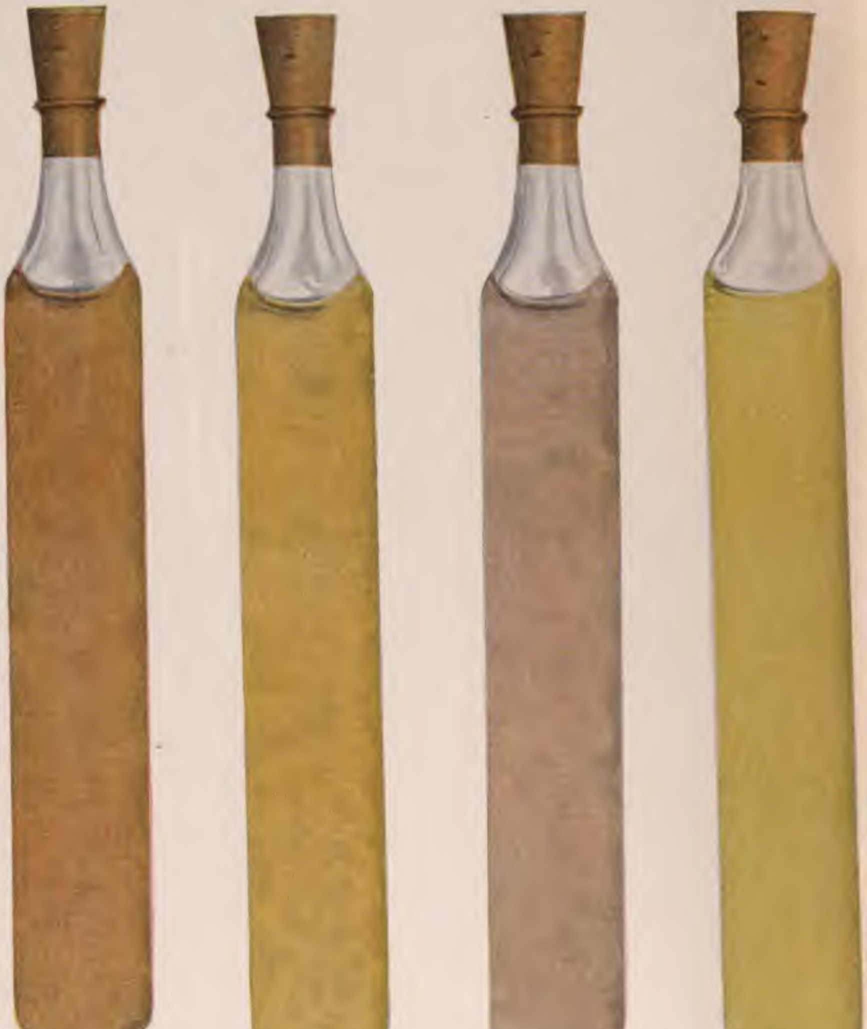
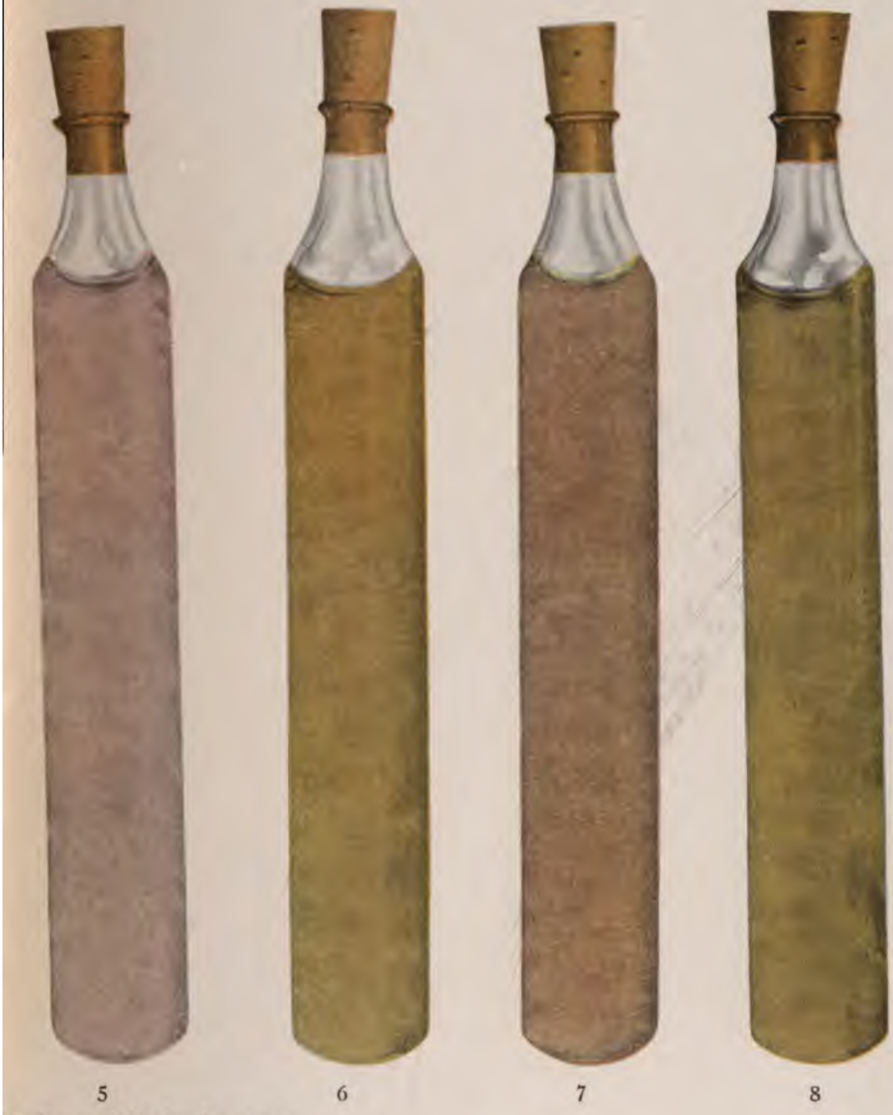


FIG. 14.—Specimens of norm

1. Mrs. M., Cholecystitis, Oct. 13, 1917. Dark yellowish brown.
2. Mrs. P., Cholelithiasis, March 9, 1916. Golden yellow, turbid.
3. Mrs. S., Cholelithiasis, Feb. 28, 1916. Brownish purple, turbid.
4. Mrs. N., Normal, Feb. 25, 1918. Golden yellow, clear.

(*From "Medical*



nd abnormal duodenal contents

5. Mrs. W., Pancreatitis, March 6, 1916. Purple, clear.
6. Mrs. J. H. McE., Nov. 24, 1917. Dark green, yellow tinge, slightly turbid.
7. J., Cholecystitis, ulcus duodeni, April 19, 1916. Dark brown, tinged with yellow.
8. Mrs. R., Cholelithiasis, Feb. 15, 1914. Greenish, turbid.

d," May 25, 1918.)

Liver, Gall-bladder and Biliary Ducts.—Bile is a product manufactured by the liver. It has no digestive qualities and is, therefore, considered as an excretion. It leaves the liver through the biliary ducts and either enters the duodenum directly or after a sojourn in the gall-bladder. Diseases of the liver are apt to produce changes in the bile which will involve the entire output of this excretion, while a pathological gall-bladder is apt to change portions of bile, which had stayed there, by admixture of new products or decomposition.

Normal bile looks golden yellow, is pretty clear and somewhat viscid. In pathological conditions it is frequently turbid and greenish or dark brown; thus a kaleidoscopic variety of colors is encountered. The following illustration[1] contains a colored plate of a number of samples of normal and abnormal duodenal contents (representing principally bile).

Not only the bile and its qualities, but also its presence or absence in the duodenum is frequently of diagnostic import.

Before discussing the diagnostic points which the direct examination of the bile furnishes it is well to first describe the *method of obtaining the duodenal contents* for bile inspection.[2]

This is usually done in the fasting condition by aspiration. It should be performed carefully, aspirating slowly with the syringe every minute or so, with frequent intermissions.

In case the aspiration has been performed five to ten minutes and nothing has yet appeared, two means may be employed to attain the desired end: One is by the injection of secretin subcutaneously and aspirating three to five minutes later; the other and principal method consists in employing duodenal lavage. The latter is performed in the following manner: The piston of the syringe is slowly withdrawn, the empty barrel is then filled with water (blood temperature) and raised. The latter usually begins to flow into the duodenum; if it does not, slight pressure may be exerted by pushing the piston into the barrel for a half to three-quarters of a minute in order to start the flow. The piston is again withdrawn, the flow, however, continues. Before the barrel is completely empty it is quickly lowered in order to make some of the fluid return. If this fails the procedure is repeated. Admixed with the outflowing water there is usually bile present which can serve for the examination.

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[1] Medical Record, May 25, 1918.

[2] Max Einhorn: Direct Examination of the Duodenal Contents (also Bile) as an Aid in the Diagnosis of Gall-bladder and Pancreatic Affections, American Journal of the Med. Sciences, Oct., 1914.

(*a*) *Absence of Bile. Obstruction of Bile Ducts.*—Occasionally we obtain on aspiration of the duodenal contents at first only a clear or slightly amber-colored fluid. It is of alkaline reaction and contains the pancreatic ferments. Usually after waiting a short time, and after repeated aspirations, a golden-yellow fluid (containing bile) appears. This has no diagnostic significance. If, however, after patient waiting and aspirating only pancreatic juice but no trace of bile appears it may be of some importance, particularly in cases of chronic jaundice. If bile is present in the duodenal contents a complete occlusion of the common bile-duct can be excluded. If the bile is entirely missing and pancreatic juice is present it points to the seat of the obstruction above the common duct.

Absence of both bile and pancreatic juice, as already stated above, speaks for a mechanical obstruction of the common duct just above Vater's papilla, thus blocking the entrance into the duodenum of either bile or pancreatic juice. In these instances it is advisable to ascertain positively the position of the capsule end of the tube in the duodenum by the milk test or Roentgen rays, as there is otherwise very little to go by. In one case of probable neoplasm of the pancreas with secondary involvement of the liver there could be found no bile in the duodenal contents after systematic aspiration, while the duodenal bucket left in the digestive tract over night returned filled with bile, the thread likewise showing bile for several inches near the bucket. There was no jaundice present. It is difficult to explain this occurrence. Possibly the tumor in the standing or sitting postures of the patient interfered with the outflow of bile while the obstacle did not exist in the recumbent position.

As the duodenal contents change very quickly in appearance, it is essential to examine them immediately after withdrawal. In order to preserve a specimen for demonstration or later consideration, an artificial reproduction of the sample by means of anilin dyes can be made. I[1] use for this purpose the following stock solutions: (1) yellow (MXX); (2) red (eosin); (3) naphthol green anilin; (4) nigrosin black; (5) methyl blue, and (6) French chalk and water.

A small vial is filled two thirds with clear water, and as much of the yellow to correspond with the sample to be represented is added. Thereupon is added whatever mixture is needed: red to represent a brownish tint, green to effect greenish discoloration, and French chalk to imitate turbidity. After a little practice the imitated samples will resemble more closely the real contents.[1] These artificial samples can be kept indefinitely without change, and will bring back to memory the exact appearance of the original fluid, immediately after its withdrawal from the duodenum.

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[1] Max Einhorn: The Duodenal Tube as a Factor in the Diagnosis and Treatment of Gall Bladder Disease, Journal of Amer. Med. Assoc., June 17, 1916.

(*b*) *Catarrhal Jaundice.*—The bile appears scantily, is clear, and reveals an admixture of mucus at intervals.

(*c*) *Cholecystitis with or without Gall-stones.*—The bile is usually turbid and somewhat greenish, occasionally alternating with clear yellow bile. Cholecystitis with complete obstruction of the cystic duct furnishes a clear yellow bile as the latter coming direct from the liver has no opportunity of a sojourn in the gall-bladder.

(*d*) *Chronic Hemolytic Jaundice.*—There is intense icterus, a swollen liver, and turbid bile constantly present in the duodenum.

(*e*) *Echinococcus of the Liver.*—Bile dark green, turbid with admixture of some blood.

Diseases of the liver and primary anemias will have to be further investigated, with regard to the changes they manifest in the biliary products. A beginning in this direction has been made by the studies of S. Bondi[2] and H. Salomon[3] in Vienna, and Giffin, Sanford and Szlapka[4] in this country. The urobilinogen content of the duodenal contents was considerably increased in pernicious anemia, while secondary anemias failed to show this phenomenon.

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[1] I am indebted to Mr. I. Abraham for assisting me in imitating the specimens, and selecting the above dyes.

[2] S. Bondi: Arch. f. Verdauungskr., 1913, p. 692.

[3] S. Bondi und H. Salomon: Zur Beurteiling der Pankreas-saftsecretion, Wiener med. Wochenschr. 1913, p. 1722.

[4] H. Z. Giffin, A. H. Sanford, and T. L. Szlapka: The Estimation of Urobiligen and Urobilin in the Duodenal Contents, Amer. Jour. Med. Sciences, 1918, vol. 155, p. 562.

CHAPTER IV

THE DUODENAL TUBE AS A THERAPEUTIC MEANS

Although primarily devised for diagnostic purposes the duodenal tube appeared to promise well for therapeusis. As a matter of fact, soon after its arrival duodenal alimentation was instituted and duodenal lavage employed. A short while afterward the duodenal tube was made use of for the instillation of remedies and gases, and ultimately of fluids. A detailed description of these different procedures will now be given.

DUODENAL ALIMENTATION[1]

Description of the Method.—The duodenal pump or tube can be used for the introduction of food into the duodenum. This kind of feeding is designated as "duodenal alimentation." The method consists simply in introducing the duodenal pump into the digestive tract, and feeding is established through it, as soon as its end is in the duodenum. The apparatus is left in the digestive system (*in situ*) for the entire period of duodenal alimentation

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[1] Max Einhorn: Duodenal Alimentation, Med. Record, July 16, 1910; Further Remarks on Duodenal Alimentation, Interstate Med. Journal, vol. 17, No. 10, 1910; Experiences with Duodenal Alimentation, Med. Record, March 9, 1912; Indications for and Demonstration of the Method of Duodenal Feeding, The Postgraduate, June, 1913; The Beneficial Effect of Duodenal Alimentation in Cirrhosis of the Liver, Med. Record, July 26, 1913; The Importance of Duodenal Alimentation in Severe Dyspepsia Occurring after Gastroenterostomy, Med. Record, June 16, 1917; A case of Duodenal Peforation Successfully Treated by Duodenal (Jejunal) Alimentation, Med. Record, Nov. 30, 1918; Results of Doudenal Alimentation in Peptic Ulcers, Med. Record, July 19, 1919.

(2–3 weeks). To facilitate the injection of food a small table support and a three way stopcock with crank can be employed (see Fig. 15).

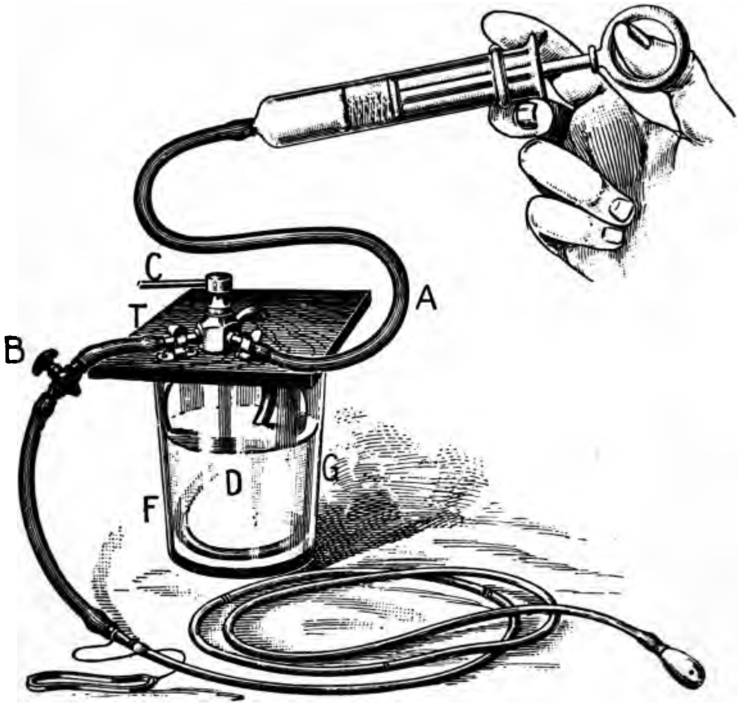

FIG. 15.—The duodenal feeding apparatus, with table support. A, tube leading to syringe; B, tube leading to duodenal pump; C, crank; D, tube leading to fluid; F, fluid; G, glass; T, table support. When crank C is turned parallel to A, fluid can be aspirated from the glass into the syringe. When C is moved parallel to B, the fluid from the syringe can be emptied into the duodenum.

Fluids and pure milk can also be given by attaching an irrigator, provided with a flow regulating stopcock or screw, to the duodenal tube.

The method of introducing the tube and also how to ascertain whether it has reached the duodenum has been described above (p. 32–35 and need not be repeated here.

It may, however, be added that it may be best to give the patients liquid food every two hours by the mouth until the tube reaches the duodenum.

Usually there is no great difficulty in making the tube reach the duodenum. There are, however, cases in which duodenal alimentation is urgent, and in which the tube fails to pass the pylorus under ordinary circumstances. It will, therefore, not be superfluous to give a few hints in this respect.

Measures to Facilitate the Passage of the Tube.—Taking of food, lying on the right side, moving about, effervescent drinks, aperients, and atropin may be employed for hastening the passage of the tube into the duodenum. Generally it is best to proceed as follows:

If the tube, after a sojourn of 3 hours (or—if it had been introduced the night before at retiring—in the early morning), has not reached the duodenum, then patient is instructed to lie half an hour on his right side. Aspiration is then tried; if chyme (*i.e.*, gastric contents) is obtained, patient is given something to drink and told to move about (walking) for 10–15 minutes. The examination again showing that the tube is in the stomach, Selters or Vichy water or any drink charged with carbonic acid gas is insittuted. Half an hour later aspiration is again performed. The tube, showing mark III at the lips, having failed to enter the duodenum, patient is given atropin gr. 1/120. One hour later or thereabout another examination is made. The tube still being in the stomach, an effervescent drink is given. After waiting a few hours more and still finding the tube in the stomach, an aperient (magnesia sulphate or citrate) is employed.

Time is an essential factor in accomplishing our purpose. If, however, after waiting two days and using the measures described, the tube is still found in the stomach, it usually indicates an organic stenosis of the pylorus. In such instances generally operative intervention is demanded. When, however, the conditions for performing the latter are unfavorable, pushing the tube through by means of a bead attached to it may be tried.

Proceed as follows: The tube is withdrawn, cleaned and made sterile. Then a bead, size 14–15F, is wrapped up in gauze and attached by means of a braided silk string (English No. 5), about 20–25 cm. long, to the capsule end of the tube. This is best done by pulling the string through the lowest two openings of the capsule and fastening the latter to the string by a double knot.

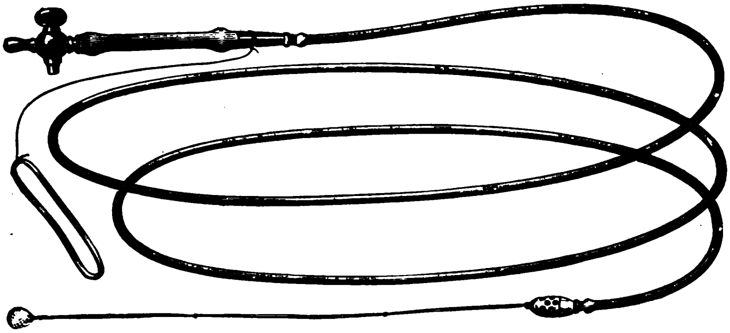

FIG. 16.—The duodenal tube with bead attached.

The bead is now introduced into the pharynx of the patient and by drinking water made to enter the esophagus. As soon as the capsule of the tube reaches the lips, it is pushed forward into the pharynx and patient given another mouthful of water. This usually engages the tube into the esophagus, which after a short while reaches the stomach. The remaining steps of the procedure are carried out as described at the introduction of the duodenal tube (p. 32).

The bead, being much smaller, frequently passes the pylorus and drags the string and later the capsule behind it. If the pylorus is not too greatly strictured, the duodenal tube is in this way pulled through this narrow passage into the duodenum.

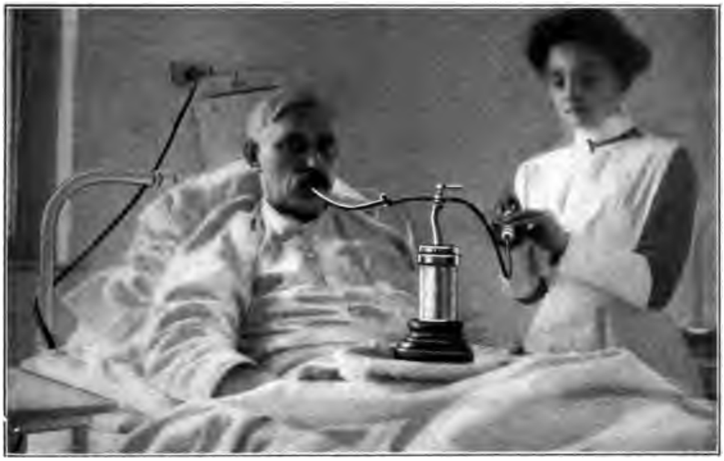

FIG. 17.—Patient being fed through the duodenal tube.

In two cases of benign pyloric obstruction I succeeded by the bead procedure to carry out a course of duodenal alimentation, after all other means of facilitating the entrance of the tube into the duodenum (even after waiting as long as three days), had failed to accomplish the desired result.

Mode of and Material for Nutrition.—The food is usually given every two hours, eight feedings a day. The standard food is milk (7 to 8 ounces), one raw egg, and a tablespoonful or two of lactose. The lactose sometimes creates diarrhea and should then be omitted. In some cases, where it is essential to see that there is no loss of flesh, butter (1 to 2 drams) may be added in every alternate or in each feeding. It is then necessary to add a teaspoonful of fine flour to each feeding, in order to bind the butter and effect a thorough mixture. Only a few patients cannot stand the milk, the latter creating such a disturbance that it must be eliminated. Such patients tell you that they never could take milk anyway. Here, instead of milk, water with barley or pea flour or vegetable milk can be substituted, Whatever is fed to the patient must be of blood temperature—neither cold nor hot—and it must be given slowly.

With regard to the method of feeding again: The temperature must be just right. The food introduced must be free from thick particles. All the food should be strained, because in passing through the long fine tube the latter would easily become clogged if this precaution were not taken. A thin tube is better for the patient. The smaller the tube, the pleasanter for the patient; but, on the other hand, the more difficult the handling of it. After each feeding, before closing the stopcock, a little water and then some air should be injected, in order to keep the tube always empty. If one is not careful to clean out the tube with water and air, the end becomes clogged in a day or two, and the tube has to be taken out and replaced, with a great deal.of inconvenience to the patient, as well as to the doctor and nurse, and that tube is often spoiled. Where patients are under strict supervision, nothing of that kind happens. It is simply faulty technique when it occurs.

Another point is that while the patient has the tube in, his mouth should frequently be washed out with some good mouth wash. If these patients do not eat anything, there is nothing to cleanse off the surface of the tongue, and it is very essential that that should be kept clean.

The tube is left in permanently during the course of this treatment. Outside of the feeding, the patient is given a pint or a quart of saline by the duodenal tube. The saline may be given either with the syringe or by connecting an irrigator to the tube. The main point is to let the fluid run in slowly and at blood temperature. If the patient does not like that, it may be given into the rectum by the Murphy drip method, for the bowels absorb saline very well. The food is the vital thing. By this method we accomplish perfect nutrition and everything is utilized.

It is self-understood that many other nutritive materials may be given through the tube, provided they do not clog up the pipe. Thus all kinds of soups (beef, vegetable or cream), beef juices or extracts, likewise fruit and vegetable juices, thin gruels, emulsions of nuts and sweet almonds, condensed or dried milk (dissolved in water), fine meat powder or cereal flours well diluted may be employed. One provision must be made, that everything given through the tube must be strained.

Results.—Duodenal alimentation is a mode of artificial feeding by means of which adequate nutrition can be indefinitely maintained. That there need be no loss of weight during this mode of alimentation can be easily ascertained from patients, whose weight remains constant, or even shows an increase. A study of the nitrogen metabolism during duodenal alimentation, undertaken by Rosenbloom and myself,[1] has, likewise, demonstrated the fact that there is no nitrogen loss in the organism, the latter being rather able to add to its nitrogen reserve.

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[1] Max Einhorn and Jacob Rosenbloom; A Study of Nitrogen Metabolism in Three Cases of Duodenal Alimentation, Amer. Journal of Med. Sciences, July, 1911.

The results of duodenal feeding are very satisfactory. We must, however, add the following explanation: Subjectively all patients with few exceptions were distinctly improved. That means there were present either no pains at all or only very slight pains after the partaking of food. Nearly all the patients were able to eat an ordinary mixed diet a few days after the period of duodenal alimentation. A marked increase in weight was later on observed in most of the patients. Objective improvement could be found in three ways. (1) In some cases, in which the pylorus could be felt as a small oval swelling (about the size of a walnut), probably caused by a spastic condition, the tumor disappeared during the period of duodenal feeding and did not return afterwards. (2) In nearly half of all the cases of ulcerations of the stomach and duodenum, in which before duodenal feeding the thread test was positive, it became negative after treatment. This would point most likely to the fact that an actual cure of the ulcer had taken place. (3) In some marked cases of ptosis and dilatation of the stomach a considerable change of the position and size of the stomach during the period of duodenal alimentation was observed. In a number of cases the organ became much smaller. In these instances the stomach before treatment extended down to the os pubis, as could be easily demonstrated by the splashing sound; after treatment, however, the lowest part of the organ was found one finger's breadth above the navel or in the region of the navel.

In two cases of perforation, one of the stomach[1] and one of the duodenum,[1] duodenal alimentation as a sole measure accomplished a cure. In these instances the extremely weakened condition of the patient did not admit of any operative intervention. Their lives would have been surely lost had not this alimentary regime been applied.

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[1] N. G. de Rosas: Ulcera del estomago perforada y abceso subfrenico; alimentacion duodenal de Einhorn-Curacion, Revista Medica Cubana, Dec., 1916.

In a number of almost fatal hemorrhages resulting from peptic ulcers duodenal alimentation, likewise, proved to be a life-saving measure.

Again in postoperative severe dyspepsias,[2] likewise in those caused by cirrhosis of the liver[3] and a very irritable heart, doudenal alimentation is usually accompanied by great benefit.

Duodenal alimentation has been successfully employed by a great number of clinicians and surgeons here and abroad. Chief among them are, Dr. Wm. Gerry Morgan and Dr. Verbrycke of Washington, D. C., Chas. G. Stockton and Allan Jones of Buffalo, N. Y., Hemmeter and Friedenwald of Baltimore, C. J. MacGuire, L. Stieglitz, M. Gross, Held, S. Basch, Geo L. Laporte, Willy Meyer, H. Fischer, S. M. Milliken, H. T. Rafsky, W. Van Valzah Hayes, A. F. Chace, all of New York, C. Jones of Pittsburgh, R. F. Chase of Portland, Me., Eggleston of Battle Creek, Mich., L. Montané Félix Pagés and N. de Rosas of Havana, Cuba, and P. Lazarus, F. Frank, Magnus Levy, and P. Junghans abroad.

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[1] Max Einhorn: A Case of Perforation of the Duodenum Treated Successfully by Duodenal (Jejunal) Alimentation, Med. Record, Nov. 30, 1918.

[2] Max Einhorn: The Importance of Duodenal Alimentation in Severe Dyspepsia Occurring after Gastroenterostomy, Med. Record, June 16, 1917.

[3] Max Einhorn: The Beneficial Effect of Duodenal Alimentation in Cirrhosis of the Liver, Med. Rec., July 26, 1913.

Indications.—The indications for this method of treatment are: First, ulcerations of the stomach and duodenum. Second, a great many cases of dilatation of the stomach without organic obstruction; extreme atony, no matter whether there is a pyloric spasm present or not. Third, in cases where nutrition is difficult, nervous vomiting, vomiting of pregnancy, etc. One might at first think it would be impossible to apply this in usch cases, for the tube would be vomited, but this is not so.

We at first apply some remedies to make it possible for the tube to remain in the stomach, but as soon as it gets into the duodenum or farther down, the vomiting ceases, or the patient only vomits something from the stomach; as a rule, they do not eject the tube. In many instances where there is very severe vomiting, this method of alimentation is the only feasible one. A fourth, indication, is disease of the liver, and still another, fifth, is inoperable cancerous condition of the stomach or cardia, where the stomach is not closed up and the duodenum can be reached. In such conditions this method can be applied and bring comfort to the patient. Sixth, perforation of the stomach and duodenum, when operative intervention appears impossible, should be subjected to duodenal alimentation. Seventh, cardiac digestive irritability, if present to such a degree that the ingestion of food into the stomach becomes impossible, forms an indication for duodenal feeding. Eighth, extreme anorexia (no matter whether complicated with sitophobia or not), in which it becomes impossible to maintain nutrition by the usual methods at our command, demands the application of duodenal feeding. Ninth, severe dyspepsia (vomiting, pains and the like), appearing some time after a gastroenterostomy and persisting for a long period, is frequently relieved by duodenal feeding. Tenth, copious hemorrhages of the stomach and duodenum endangering life, by the great loss of fluid and subsequent inanition are often helped by duodenal alimentation.

DUODENAL INSTILLATION OF FLUIDS AND GASES

Duodenal Instillation of Fluids.—Ever since the duodenal tube was employed as a therapeutic measure, water or saline (in quantities of a pint to a quart) was injected through it into the duodenum. Recently, however, this measure was adopted for instilling very large amounts of fluid into the duodenum. In Raynaud's disease or thrombo-angiitis obliterans Dr. Willy Meyer of New York and following him other surgeons of repute have found the best results from flooding the organism with large quantities of water (9–10 quarts daily). In as far as such large quantities of fluid can not be taken by the patient with impunity in the ordinary way, it is given best according to Dr. Willy Meyer by duodenal instillation.

The method consists in introducing the duodenal tube, and beginning the instillation when the latter has reached the duodenum. This is best done by attaching an irrigator to the tube. The former must be provided with a flow-regulating stopcock or screw. Patient is given his meals in the ordinary way by mouth; nor is there any need of changing his bill of fare. At the same time he is given about nine quarts of Ringer's solution daily through the duodenal tube, which is left *in situ* for a period of about four weeks.

The flushing of the system with fluids has a remarkable effect on these patients with Raynaud's disease, diminishing pains, and restoring sleep, so that this measure, for the present, appears to be the remedy par excellence for this terrible malady. The same method can be applied in septic conditions or generally, whenever flushing of the organs with water is indicated.

Duodenal Instillation of Gases.—Ad. Schmidt[1] was the first to make use of the duodenal tube for the instillation of oxygen into the duodenum. He reported beneficial results by this procedure in severe catarrhal conditions of the intestines.

I have used oxygen in a number of cases. The method employed was as follows: A collapsible rubber bag provided with a metal tip opening and stopcock, also a soft rubber tube, is filled with oxygen from an oxygen tank and the stopcock tightly closed. After introducing the duodenal tube and having it lodged in the duodenum, the distant piece is attached to the oxygen bag. The stopcock is opened and gentle pressure is exerted over the bag. This liberates the gas into the duodenum. About a gallon of oxygen can be thrown into the duodenum within 15–20 minutes. It is remarkable with what rapidity this gas is absorbed from the intestinal mucosa. For after the instillation of as much as a whole gallon of oxygen the patient experiences no fullness in the abdomen, nor has the latter apparently increased in size.

The same procedure can naturally be employed for the instillation of other gases, whenever their presence in the duodenum should be required. Thus, CO_2 could be tried in painful conditions of the intestines.

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[1] Ad. Schmidt: Centralbl. f. med. Wissensch.

DUODENAL LAVAGE AND INSTILLATION OF REMEDIES

(*a*) **Duodenal lavage** is performed by attaching the barrel of the syringe or a small funnel to the duodenal tube, filling the former with water (blood temperature) and holding it raised for a little while. Provided the holes of the capsule of the tube are not clogged up by food or mucus, the fluid runs in slowly into the duodenum. Should the capsule be clogged up it is necessary to first inject the water by the syringe, using somewhat more force, in order to dislodge the obstacle. Another barrel of water (warm) is then made to flow in into the duodenum, then, before letting the barrel become entirely empty, it is lowered below the abdomen of the patient and held in this manner until the return flow ceases. The barrel is again filled and raised, and thus this performance repeated several times.

Similar to gastric lavage, duodenal lavage is performed for diagnostic and therapeutic purposes. Presence of mucus, presence or absence of bile is of significance. Washing of the duodenum in chronic duodenitis and cholecystitis is often crowned with benefit.

M. E. Jutte[1, 2] uses 1 : 1000 Sapo medicatus of which 1500 are injected; to this solution Jutte adds 14.5 gm. sodium chlorid. While the fluid runs in the patient receives abdominal massage. Within one hour he usually has a copious movement.

Aaron[3] recommends duodenal lavage (really instillation) for the treatment of intestinal stasis. Aaron employs Jutte's modification of the duodenal tube and instills into

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[1] M. E. Jutte: Transduodenal Lavage, J. A. M. A., Feb. 22, 1913, p. 586.

[2] M. E. Jutte: Transduodenal Lavage, N. Y. Med. Jour., March 16, 1912, p. 542.

[3] Chas. D. Aaron: Treatment of Intestinal Stasis by Duodenal Lavage, Med. Record, Aug. 17, 1918.

the duodenum one liter of water containing 30 grms. of magnesium sulphate and 90 grms. of sodium sulphate, first daily, then every other day.

Personally I found that in many cases 8–10 grms. magnesium sulphate and 15 grms. of sodium sulphate to one pint of water are sufficient to achieve good catharsis.

Duodenal Instillation of Remedies.—Remedies can be injected into the duodenum for two purposes: (1) to exert a therapeutic influence within the duodenum itself, or (2) to act in distant localities after absorption or prochoresis from the duodenum of special remedies whose sojourn in or passage through the stomach does not appear desirable.

Protargol or argyrol (1/2 per cent. solution) or ichthyol (1 per cent.) may be instilled into the duodenum in quantities of about 15–20 c.c. with good results in chronic duodenitis and cholecystitis. Cathartic and sedative remedies can be given to patients who have the duodenal tube in place, directly into the duodenum with quicker and prompter action than through the stomach.

Satterlee[1] employs a similar procedure for the treatment of duodenal ulcer. "The duodenal tube is left in the stomach over night, and benzyl benzoate given if pylorospasm occurs. The following morning, on an empty stomach, the duodenum is washed out with plain hot water or soda solution. This is followed by instillations of silver nitrate, 100 c.c. of the strength of 1 to 20,000 up to 1 to 1000, or 20 per cent. argyrol."

Vermifuge and entamœbic remedies may be given through the duodenum directly, avoiding their effect on the stomach in irritable conditions of this organ.

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[1] G. R. Satterlee: The Treatment of Duodenal Ulcer, Med. Record, Aug. 17, 1918.

CHAPTER V

OTHER INSTRUMENTS FOR THE PYLORUS, DUODENUM, AND SMALL INTESTINE

As a direct consequence of and on the same principle as the duodenal pump a number of instruments for the investigation and treatment of the pylorus, duodenum and small intestine have been constructed. They will be described in their natural sequence.

THE PYLORIC DILATOR[1]

The pyloric dilator (see Fig. 18) consists of a small metal endpiece to which is attached a thin rubber tube (8 mm. circumference and 1 m. long), bearing markings I = 40 cm.; II = 56 cm.; III = 70 cm. and 80 cm. Inside of the tube and attached to both ends is fastened and lodged a strong silk thread. Right next to the metal piece and fastened to it and the tube is a tiny rubber balloon, covered with silk gauze. The tube is provided with a few holes within the balloon and is connected at its distal end with a stopcock and a graduated glass syringe. The latter serves the purpose of injecting a certain amount of air into the balloon and thus inflating it.

Method.—The pyloric dilator is introduced in the same manner as the duodenal pump. After emptying the rubber balloon of its air contents (this is done by drawing the piston of the syringe outward), the cock is closed. The endpiece of the dilator is now dipped in lukewarm water and introduced in the pharynx of the patient. The latter drinks some water and the instrument moves into the stomach. It is now left in the digestive tract for several hours, or, best,

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[1] Max Einhorn: On Pylorospasm, Med. Record, Jan. 21, 1911.

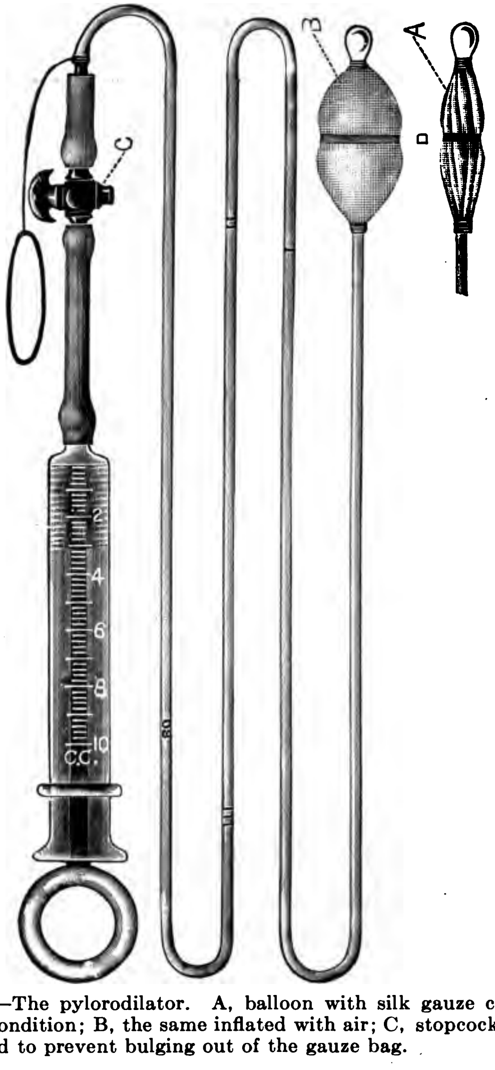

FIG. 18.—The pylorodilator. A, balloon with silk gauze covering in collapsed condition; B, the same inflated with air; C, stopcock; D, small rubber band to prevent bulging out of the gauze bag.

inserted before the patient retires, and left there over night. For in pylorospasm it, sometimes, takes a long time for the apparatus to pass into the duodenum. In the morning the stretching is performed. Before doing this, it is necessary to ascertain whether the dilator is in the duodenum. This is done by estimating the length of the tubing within the digestive tract (it should be in to mark III or 70 cm.), and by drawing the tube slightly outward. If a resistance is felt, the probability is that the apparatus is within the duodenum. In the stomach the apparatus may be moved without resistance. If no resistance is encountered the balloon is inflated and the pulling now again tried. Lack of resistance is then a positive sign that the instrument is in the stomach. In this case the balloon must be deflated and left in the digestive tract still longer. If, after inflation of the balloon, a distinct resistance is felt, then the instrument is pulled forward slowly until the pylorus is reached. Here a strong resistance is encountered and the marking on the tube generally shows mark II within the mouth. If the tube is now drawn forward there is a sensation as if the end of the instrument is held tight by something that drags along with it, not being able to escape it. It is not permissible to use much force. The balloon is then made somewhat smaller by pulling the piston of the syringe and thus

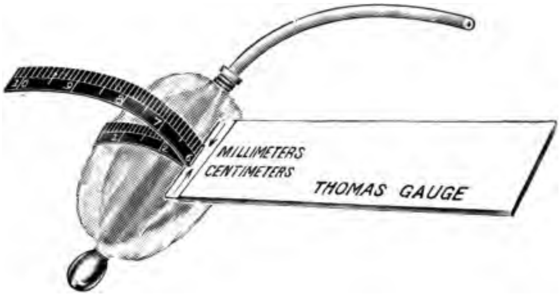

FIG. 19.—Shows how to measure the circumference of the pylorodilator with Thomas gauge.

deflating it slightly. This is repeatedly done until the end of the dilator, by a slight pull, passes through the pylorus. Using a graduated syringe one notes the amount of air in c.c. existing in the balloon during its passage through the pylorus. Within the stomach there is no resistance felt when drawing the dilator until the cardia is reached. Here the dilator should be entirely deflated and withdrawn, which is

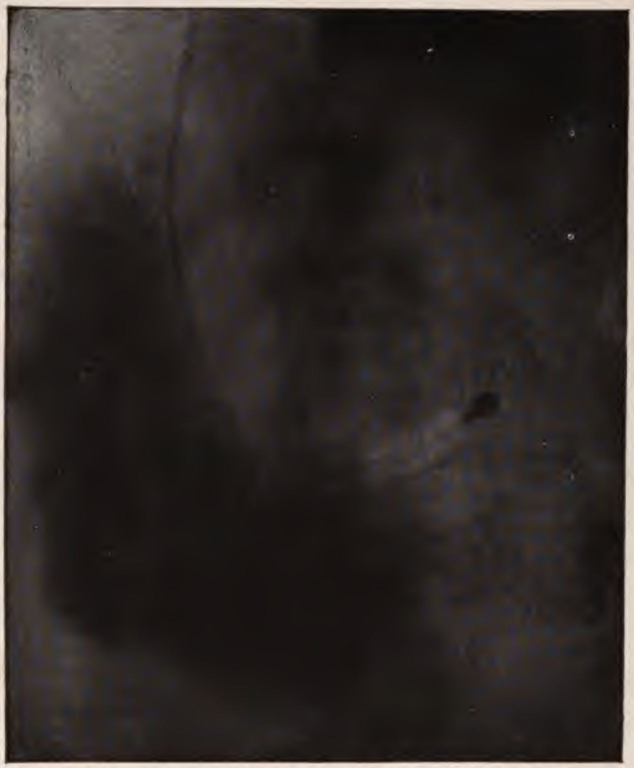

FIG. 20.—*X*-ray photograph of patient, E. F., lying with abdomen on the plate with pyloric dilator in the digestive tract and a bismuth-buttermilk mixture in the stomach. The end of the pyloric dilator is distinctly visible in the descending portion of the duodenum; right above it is the balloon filled with air, which appears as a bright oval area. The stomach is outlined as a dark area.

accomplished without trouble. Should, however, a resistance be encountered at the introitus esophagi, the patient should swallow and, while his larynx moves upward, the instrument is gently removed without applying any force.

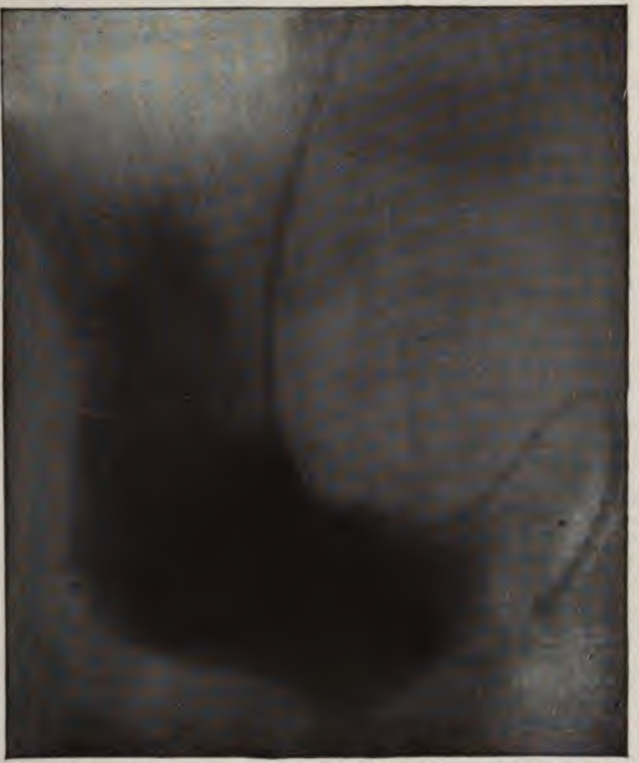

FIG. 21.—Same as Fig. 20, a few minutes later, after pulling the dilator up, in front of the pylorus. The dilator with inflated balloon is seen outside of the stomach, in the duodenum, invaginating the pylorus slightly into the stomach.

Wash the instrument, dry it off with a towel, now fill it with the same amount of air contained in the balloon when passing the pylorus and measure the circumference with Thomas' adaptable gauge (Fig. 19).

The following radiograms (20, 21, 22)[1] of patient E. F. illustrate the position of the dilator during the entire procedure: A, Endpiece with balloon in the descending portion of the duodenum; B, the balloon just in front of the pylorus pushing the latter toward the left; C, balloon after its passage through the pylorus, lying in the cardiac portion of the stomach. The stretching may be repeated once a week or oftener.

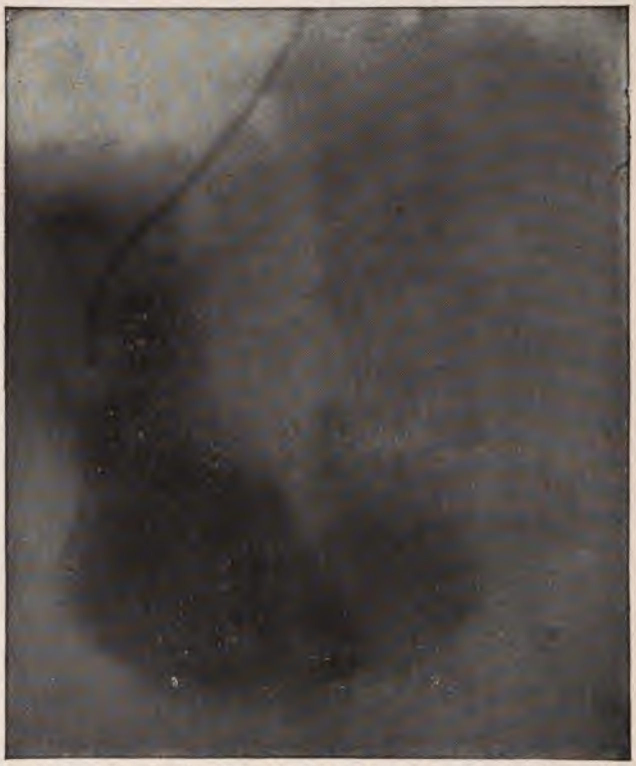

Fig. 22.—Same as Fig. 21, a few minutes later, after having pulled the dilator through the pylorus into the stomach. The end of the dilator can be seen in the cardiac portion of the stomach.

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[1] I am indebted to Dr. L. G. Cole for these beautifully executed radiograms.

For infants the pyloric dilator just described, but much smaller, can be used. Generally, however, in this instance the following instrument, which is a modification of the dilating pyloric catheter is employed.

THE INFANTILE DILATING PYLORIC CATHETER[1]

Mode of Application.—The infant is given one of the duodenal olives attached to a silk thread (about 25 inches long), either the night previous to the stretching or about six hours ahead. Three to four hours after the last feeding, the stretching, provided the olive has reached the duodenum, is performed as follows:

The fastened thread is cut off near its outer end and pulled through the eye of the dilating catheter. The latter is pushed with the right hand into the mouth, esophagus, and stomach along the thread, which is held securely by the left hand. This procedure must be performed gently. The catheter is then pushed still farther until a resistance is encountered which can not be overcome (this generally occurs at the angle of the duodenum "ramus horizontalis"). At this point the balloon of the catheter is filled up with air by means of a syringe. The instrument is then drawn

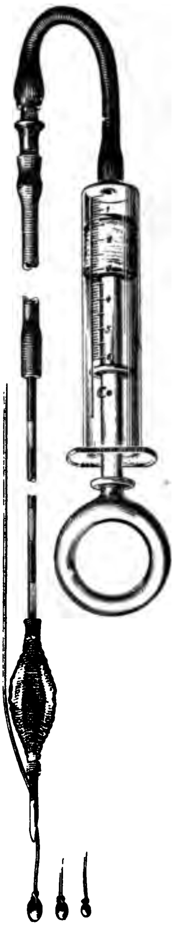

FIG. 23.—The infantile dilating pyloric catheter, with infantile duodenal olives.

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[1] Max Einhorn: Stretching of the Pylorus in Benign Stenosis, Med. Record, June 10, 1911.

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somewhat forward until it meets with the pyloric resistance. Here it is slightly deflated so, that the balloon can pass the pylorus by a gentle pull. After reaching the stomach there is no resistance felt when withdrawing the instrument until meeting the cardia. The balloon is now completely deflated and the instrument as well as the olive and the thread are withdrawn. By noting the points at which the catheter met the two resistances (pylorus and cardia) the exact distances of these two orifices can be calculated.

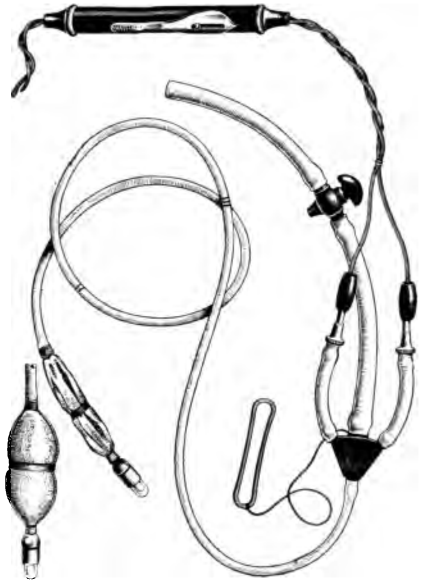

FIG. 24.—The pyloric dilator and diaphane.

THE PYLORIC DILATOR AND DIAPHANE[1]

The pyloric dilator and diaphane consists of a pyloric dilator with a tantalum lamp at the end (cold lamp). (See Fig. 24.)

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[1] Max Einhorn: Widening of the Pylorus without Operation, N. Y. Med. Journal, May 11, 1912.

The advantage of this instrument consists in the fact that it is possible to ascertain whether the end is in the stomach or duodenum by simply connecting it with a weak electric current and looking at the patient's abdomen in a dark room. The lamp being in the stomach, a large area on the left side of the abdomen appears luminous (stomach). When, however, the lamp is lodged in the duodenum, a faint light in a small, lengthy area appears to the right of the linea alba, while nothing is seen over the gastric region. It is self-understood that when using this instrument no food should be in the stomach, as it would obscure the picture.

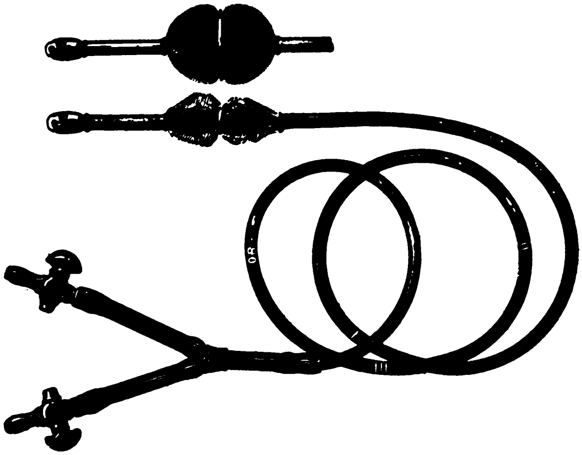

FIG. 25.—The pyloric dilator and aspirator. A, canal leading to aspirating end; B, canal leading to inflatable balloon.

THE PYLORIC DILATOR AND ASPIRATOR[1]

Another modification of the pyloric dilator serving to facilitate the recognition of its position, is the pyloric dilator and aspirator, which consists of a tube provided with two canals, one leading to the inflatable balloon, the other to the aspirating openings of the capsule.

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[1] Max Einhorn: Widening the Pylorus without Operation, N. Y. Med. Jour., May 11, 1912.

THE DOUBLE BALLOON PYLORIC DILATOR[1]

Another modification of the pyloric dilator has for its object stretching of the pylorus *in situ,* which is impossible with the other instruments. For these can merely be pulled through the pylorus, but can not be made to stay there any length of time. This modified dilator is provided with a double canal tube and two balloons, which can be inflated separately. (See Fig. 26.)

When in the duodenum the end balloon is inflated and pulled up in front of the pylorus, then allowed to recede about half an inch. Thereupon the second elongated balloon, lying just within the pylorus, is inflated and left in position for about one minute. It is understood that the physician must know exactly the amount of air he is permitted to introduce or the size of the balloon stretching the pylorus, so that no harm can result. Ordinarily I first measure the lumen of the pylorus with an ordinary dilator before applying the double balloon instrument.

THE DUODENAL OBTURATOR[2]

The duodenal obturator resembles in construction the pyloric dilator and aspirator, with the difference that the position of the dilating balloon and the aspirating or injecting arrangement is reversed. The balloon here lies at the end and the aspirating canal above. (Fig. 27.)

[1] Max Einhorn: N. Y. Med. Jour., l. c.

[2] Max Einhorn: New Instruments for the Duodenum and Small Intestine, Med. Record, June 21, 1913.

When the end of the instrument is way down in the duodenum, the balloon can be filled up with air to such a degree

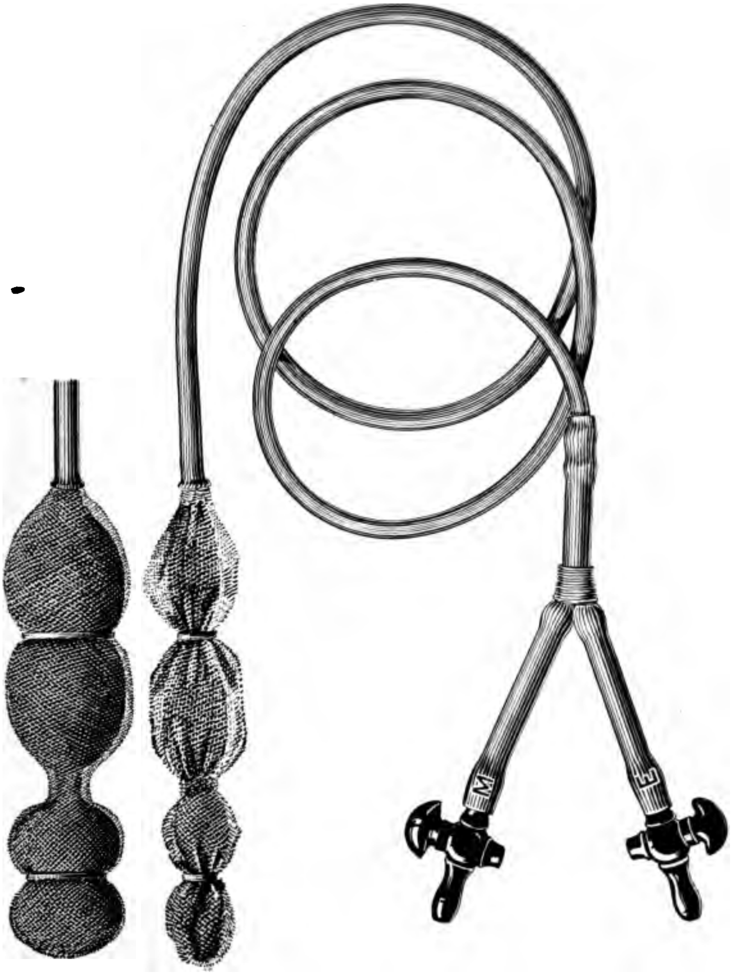

FIG. 26.—The double balloon pyloric dilator. E, canal leading to end balloon; M, canal leading to the oval middle balloon.

that the lumen of the duodenum is shut off. By injecting a fine bismuth and acacia mixture through the aspirating

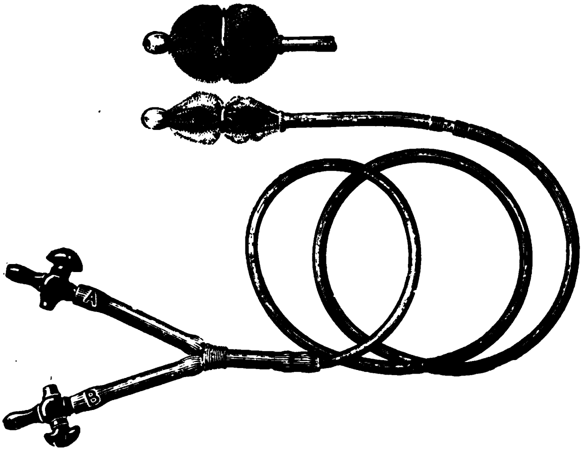

Fig. 27.—The duodenal obturator. B, canal leading to inflatable balloon; A, canal leading to aspirating or injecting arrangement.

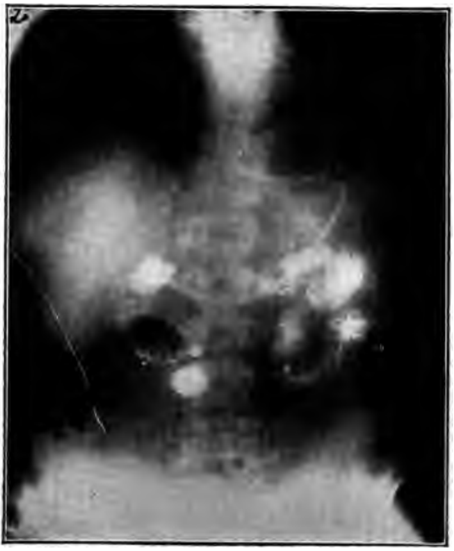

Fig. 28.—Shows radiograph of patient H. L. with duodenal obturator deep in the duodenum. The balloon was merely partly filled, so that the bismuth escaped by it into the lower portion of duodenum and beginning of the small intestine.

canal, the duodenum above the balloon becomes filled with the fluid up to the pylorus. An X-ray taken in this stage will show the shape of the duodenum. (Fig. 28.)

THE INTESTINAL DELINEATOR[1]

The intestinal delineator is another instrument designed for X-ray work. It consists of a thin very flexible rubber tube (size 4 F) through which run two wires and a silk thread. At the end there is either a metal ball or a tiny bucket. The apparatus is two to three meters long (Fig. 29).

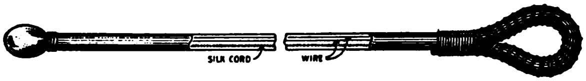

FIG. 29.—The intestinal delineator.

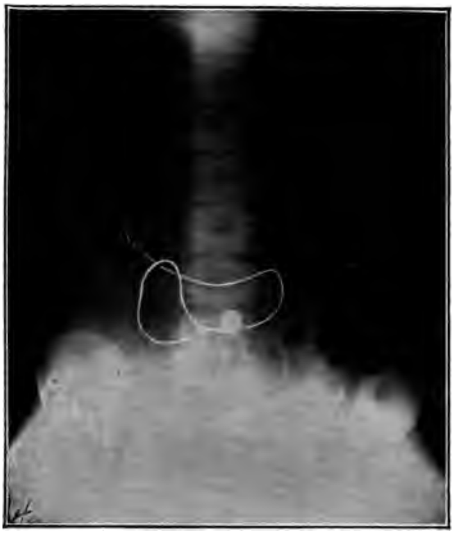

FIG. 30.—X-ray picture of patient H. A., with intestinal delineator *in situ*. The course of the instrument in the stomach, duodenum, and part of the small intestine is distinctly visible.

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[1] M. Einhorn: New Instruments for the Duodenum and Small Intestine, Med. Record, l. c.

When the delineator is in the digestive tract the *X*-ray shows its position distinctly. If the end is deep in the small intestine the course of the duodenum and the small intestine can be mapped out (Figs. 30 and 31).

I am indebted to Dr. W. H. Stewart, radiologist of the Lenox Hill Hospital, for the above excellent *X*-ray pictures which he took for me.

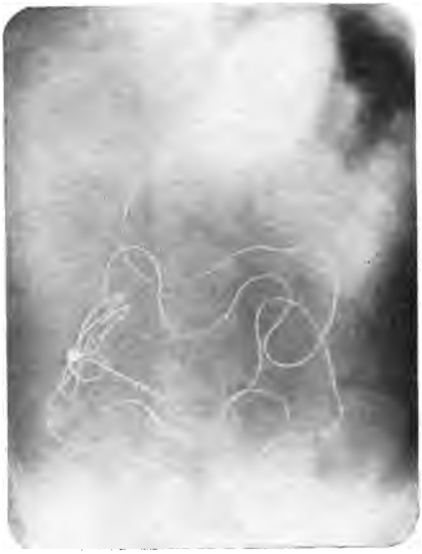

FIG. 31.—Roentgen-ray photograph of patient K., with the intestinal delineator in the digestive tract, shortly after bismuth ingestion into the stomach. The course of the intestine is seen for about nine feet beyond the pylorus.

With a delineator about 3½ meters long I had been able to vizualize by the *X*-ray the greater part of the entire small intestine. The actual length of small intestine thus demonstrated by means of the instrument was over 9 feet.[1] In drawing out the instrument, when it had reached the depth mentioned, it was done with difficulty, causing some discomfort to the patient. I became convinced that although the method was feasible it would not be practicable as a routine measure. It certainly appeared inadvisable to let the delineator enter further down into the small intestine, for the reason of the difficulty encountered in withdrawing the instrument.

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[1] Max Einhorn: Historical Sketch of the Development of the Duodenal Tube, American Journal of the Med. Sciences, Feb., 1916.

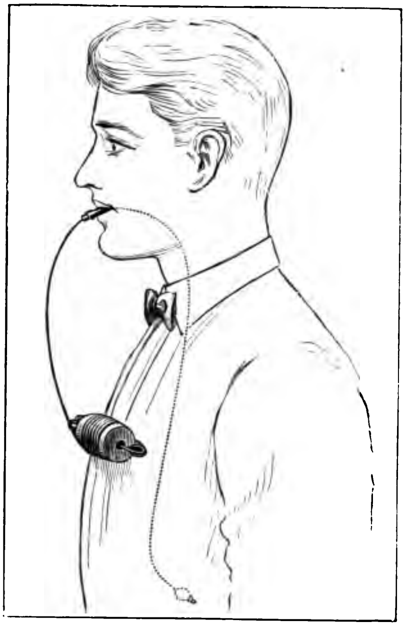
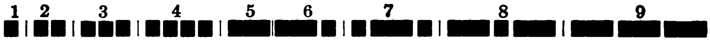


FIG. 32.—A patient with the new intestinal delineator in the digestive tract (*schematic sketch*).

Being desirous of studying the whole course of the small intestine and possibly also of the large bowel I constructed a new delineator, which can be given to the patient, with the object of its passing through the entire digestive tract and leaving it in the natural way, by the rectum. In order to fulfill this purpose the delineator must be as flexible and pliable as a string, and still possess qualities which make it visible under the *X*-rays.

The new delineator (Fig. 32) consists of braided silk through the lumen of which run 60 strands of annealed copper 0.002 inch in thickness. The string is about 30 feet long and is attached to a small metal ball (about 20 F). The string is provided with markings (made of lead surrounding the string and covered with adhesive plaster. The markings are as follows:



and indicate the length of string from metal ball in meters. The string is then drawn through a hard-rubber holder, looking somewhat like a cigar holder, which permits the delineator to be freely movable through it without encountering any friction, and which can be held in the mouth between the teeth whenever desirable. The free end of the string is then fastened to a reel and the delineator wound over it, so that the holder and the metal ball form the free end of the string on the reel.

I am indebted to Mr. A. D. Scott and J. H. McEwen, engineers, and Mr. A. E. Pfarre of Tiemann & Co., for the successful construction of the instrument.

Method.—The delineator is best given after a light breakfast in the morning. The ball is put deep into the pharynx and patient given water to drink. The instrument thus starts its journey to the stomach and then further down through the entire digestive tract. The reel is put in a pocket not too far from the mouth and attention paid that there be no obstacle to the unwinding of the string from the reel. *X*-ray pictures are best taken every two hours during the day, until the ball appears in the stool.

It is best to observe the following rules, when employing the delineator:

1. When introducing the delineator, attach it in such a manner that it can not go beyond 60 cm. This can best be done by fastening the string to the reel by means of a rubber band, after enough length has been unwound so that 60 cm. can enter the mouth.

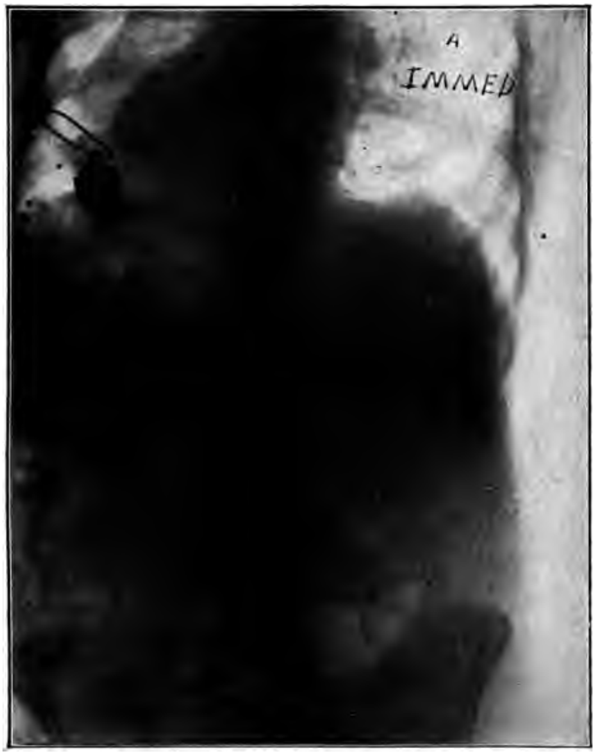


FIG. 33.—Immediately after swallowing instrument. The metal ball is visible in the stomach.

2. ½–1 hour later, detach it. Patient should not swallow it intentionally. He should not keep his mouth closed

too tight and let the delineator go, whenever there is a pull.

3. At night the holder should be pushed up to the teeth and held there in the same manner as when smoking a cigar. It is appropriate to fasten the holder to a tooth, whenever feasible, or to the cheek. Care must be taken, however, not to interfere with the gliding of the delineator, which must be freely movable along its path.

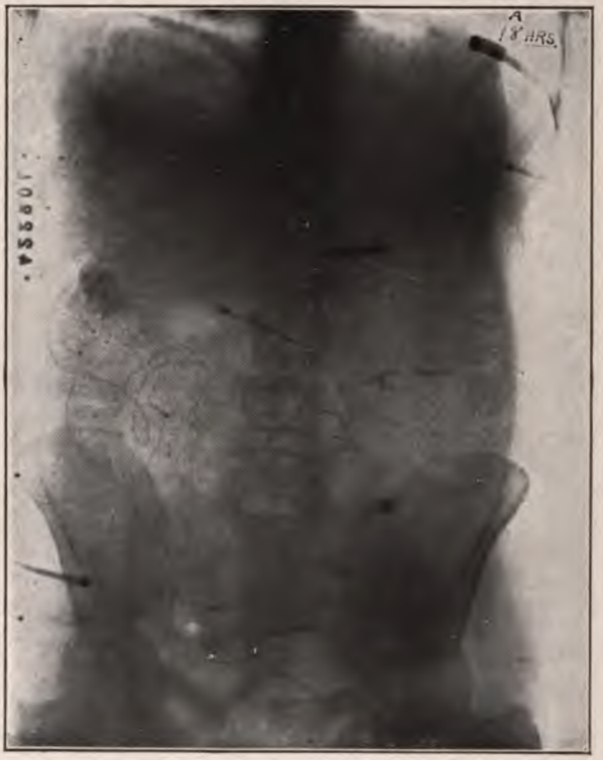


FIG. 34.—18 hours afterwards. The cord of the delineator is seen partly curled up in the stomach then running straight through all the intestinal coils. The ball is situated near the cecum.

4. The delineator should be unwound from the reel

from time to time for about 30–50 cm. so that it hangs loosely in the form of a curve.

5. When washing or dressing, patient must be careful not to disarrange the delineator.

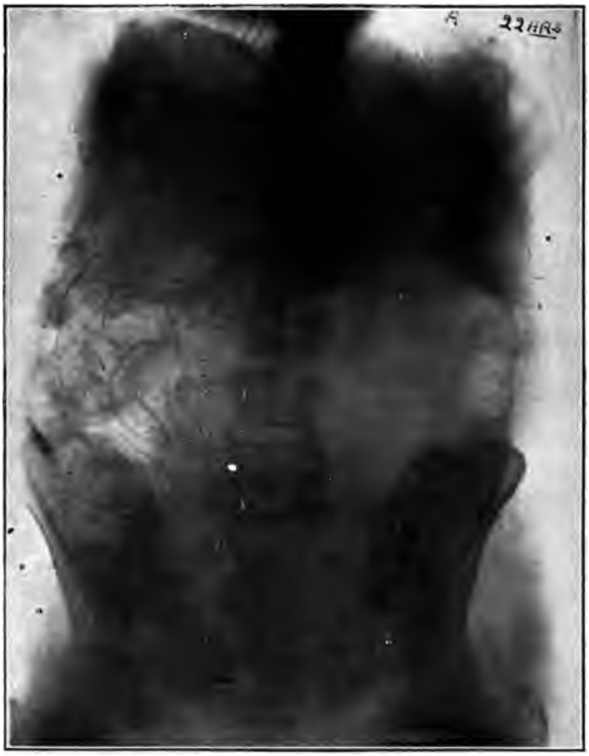


Fig. 35.—After 22 hours. The delineator represents a chart of the course of the entire small intestine; the cord runs through the gut in a single line showing no *curling* up anywhere. Then we notice the ball in the ascending colon and above it the delineator curls up in spiral form upward along the course of the large bowel.

6. While eating, the delineator must always be fastened to the reel by means of a rubber band, in such a manner that not more than 30–50 cm. can move into the stomach during the meal. The latter having been finished, the rubber is taken off and the delineator released.

7. Defecation must be performed over a commode. When the metal endpiece appears in the feces, patient should carefully lift it out of the latter, clean it, wrap it in gauze and attach it to the underclothes. Patient should inform the physician of the passage of the endpiece. The physician now cuts the delineator at the lips and allows this part of the string to enter the stomach. At each defecation, the delineator must be disengaged from the stool, cleansed and wrapped in the gauze and attached

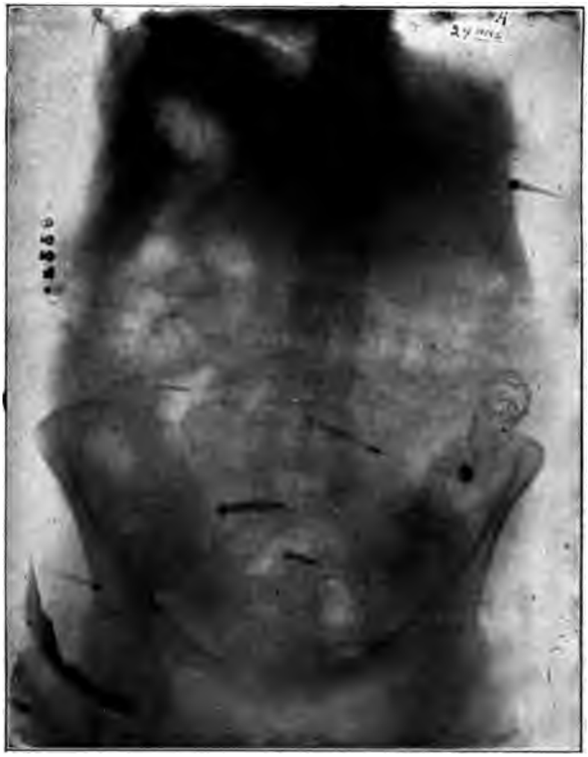


FIG. 36.—After 24 hours. Same as Fig. 35. Curling of delineator in large bowel extends higher up, and the ball has moved upward.

to the underclothes, until the whole delineator has passed. The latter should be handed to the physician.

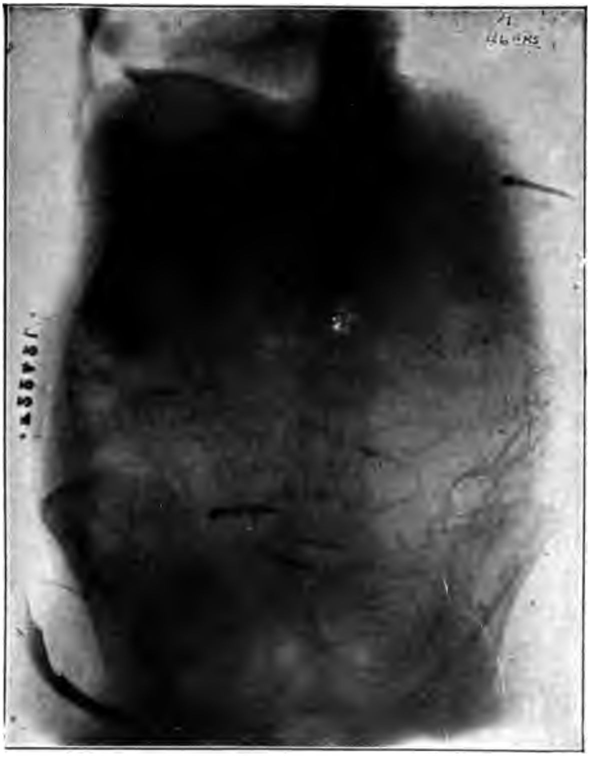


FIG. 37.—After 46 hours. Same as Fig. 35. Ball is situated in the descending colon; the spiral formation is now seen principally here surrounding the ball.

8. An *X*-ray should be taken a few minutes after the delineator has entered the stomach; then every 2–3 hours from 9 A.M. to 5 P.M. up to the time when the endpiece appears in the stool, when the last plate is taken.

Figs. 33 to 39 show *X*-ray photographs of Mrs. A. with the intestinal delineator in the digestive tract.

The new delineator was first used in Oct. 1918, on a patient of the Lenox Hill Hospital. The patient referred to, Mrs. A., took the new delineator on Oct. 14, and passed it per rectum on Oct. 18, 1918. During the whole course of the delineator's journey, she had experienced no discomfort whatever.

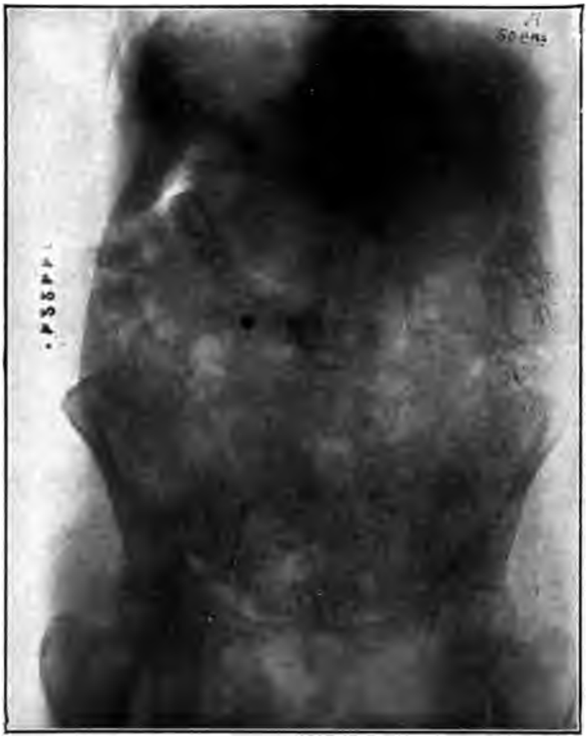


FIG. 38.—After 50 hours. Ball visible in the transverse colon (probably brought back there by anti-peristalsis) almost the entire colon mapped out by spiral formation of the delineator.

The series of plates herewith submitted illustrate the different positions of the instrument along the digestive tract at different times. It will be best to go over them in their natural sequence.

It can be easily seen from the above that the entire intestinal tract can be visualized by means of the delineator through the Roentgen rays.[1] The following points seem to be of importance.

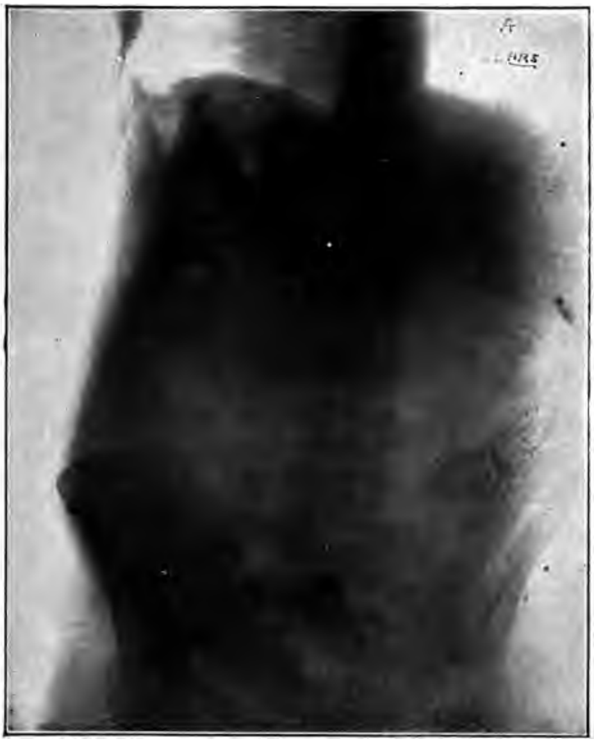


FIG. 39.—After 66 hours and previous to release of the delineator from its attachment. The cord is filling out the colon in spiral formation and the ball is situated in the sigmoid flexure.

1. The delineator runs through the entire length of the small intestine without once curling up.

2. Different from the small intestine, the large bowel shows a winding up of the string in screw form.

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[1] I am indebted to Miss Leach of the Lenox Hill Hospital for the taking of the *X*-ray plates.

3. In the small intestine the ball always runs ahead of the string and drags the latter along. In the colon the string, in spiral form, is frequently found moving ahead of the ball.

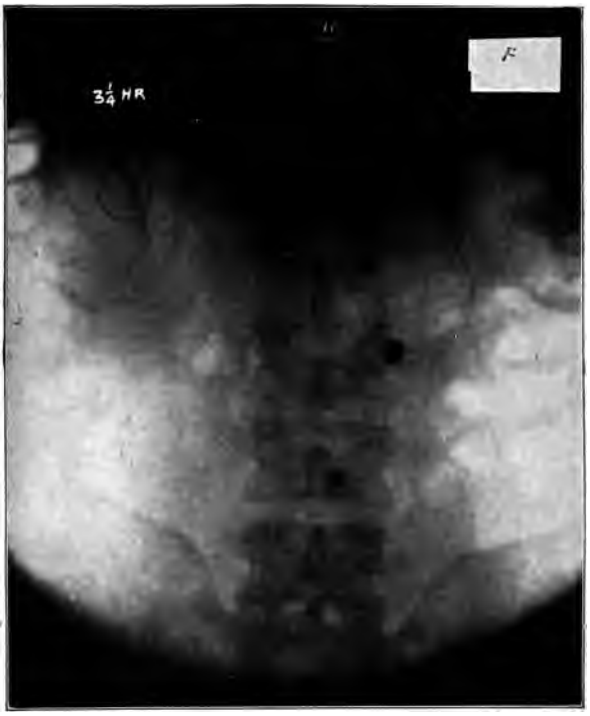

Fig. 40.—Radiograph of K. F. 3¼ hours after swallowing the delineator. The cord is visible along stomach, duodenum and a portion of the jejunum. The young man had, contrary to instructions, swallowed the whole delineator (string) during his luncheon. (*Patient K. F.*)

These normal findings will probably be of diagnostic import in pathological conditions. In obstructions along the small intestine the ball will find an obstacle in its forward passage, and the string will then curl up.

The following plates show the delineator in the digestive tract of a normal individual (K. F.).[1]

The young man, contrary to instructions, had swallowed the whole delineator (string) during his luncheon.

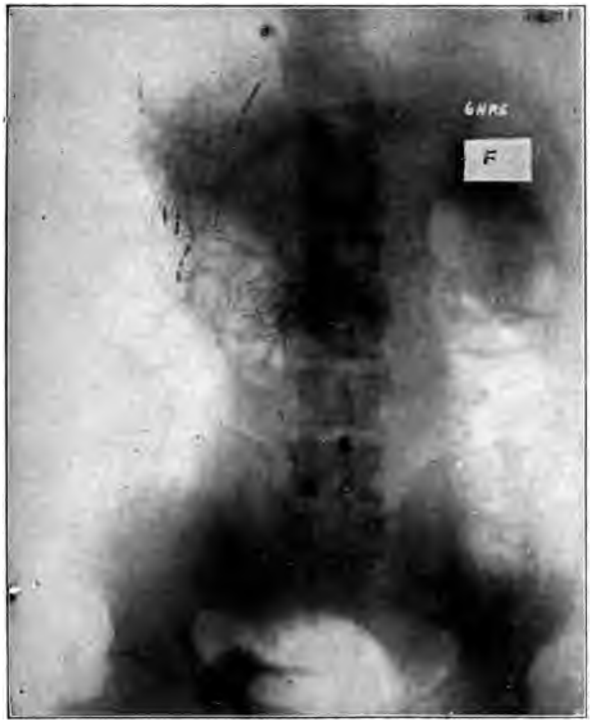

FIG. 41.—After 6 hours shows the instrument lying almost like a hair-ball tumor in the stomach. (*Patient K. F.*)

Figure 41 shows the instrument lying almost like a hair-ball tumor in the stomach. Here it took longer for the string to disentangle and leave the stomach. But when it did, it ran through the small intestine in the usual way without curling up.

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[1] I am indebted to Dr. Thomas Scholz, radiologist, for these beautifully executed *X*-ray pictures.

In the colon the spiral formation of the delineator is visible.

The markings on the delineator are well shown all along the digestive tract. It seems possible in this way to obtain an actual measurement of the length of the small intestine.

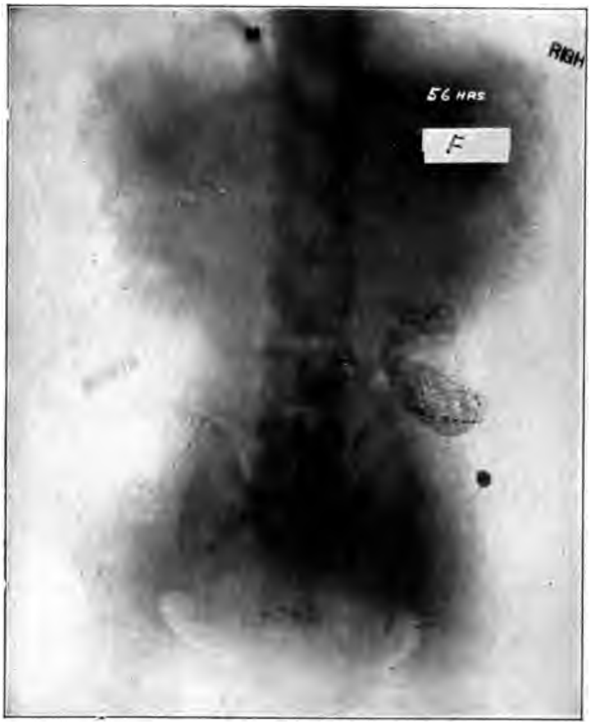

FIG. 42.—After 56 hours the spiral formation of the delineator is visible in the colon. (*Patient K. F.*)

THE SECTIONAL INTESTINAL EXAMINER[1]

This instrument (see Fig. 43) serves to examine a portion of the duodenum or small intestine, with regard to its secretion and condition of its mucosa, walling off the juices from above or below. It consists of a three-canal tube (or one outer tube (size 15F) containing two small caliber tubes) provided with two inflatable balloons between which are situated the end openings of the aspirating or injecting arrangement. The distal end of the instrument branches off into three separate tubes provided with stopcocks and markings as to where their particular canal leads (Fig. 43).

---

[1] Max Einhorn: New Instruments for the Duodenum and Small Intestine, Med. Record, l. c.

The construction of this last instrument presented many mechanical difficulties which, however, have been successfully overcome. I am indebted for help in this respect to Mr. A. D. Scott and Mr. A. E. Pfarre, of Geo. Tiemann & Co.

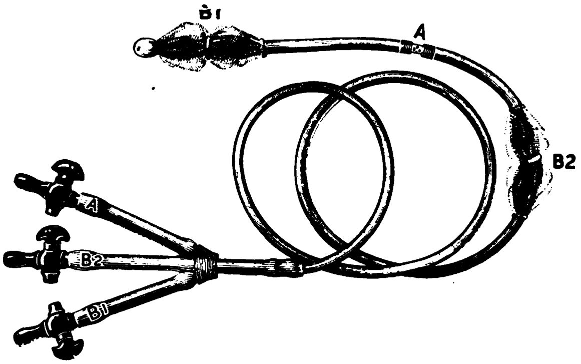

FIG. 43.—The sectional intestinal examiner. A, canal leading to aspirating or injecting arrangement, ending in several small openings A; B^1, canal leading to end balloon; B^2, canal leading to middle ballon.

Mode of Procedure.—The instrument is best introduced about one hour before retiring, and care taken that it should go in beyond mark two. When arising the tube is inspected and if it is found that mark two is way in, a slight pull will show whether there is resistance present. If so the probability is that the instrument has reached the duodenum. The middle balloon is now inflated almost to its maximum and pulled up to the pylorus. Here it finds resistance and can not pass. This makes it certain that its position is in the duodenum. Then the end balloon is likewise inflated. A few cubic centimeters (5–10) of water are injected into the separated section of the duodenum. Wait five minutes, then aspirate. A juice is then obtained which originates in the duodenum. If the instrument is just in the position mentioned, the secretion will contain duodenal and pancreatic juices and bile, for the end balloon is just beyond Vater's papilla.

THE SIMULTANEOUS GASTRO-DUODENAL ASPIRATOR[1]

Fractional examination of the gastric contents is nowadays frequently done by clinicians. The duodenal tube has made this innovation possible. The duodenal contents can likewise, be examined by the fractional method. The study of the curve of the alkalinity of the duodenal contents is probably of greater import than that of the gastric acidity.

Whenever an examination (fractional) of both the gastric acidity and of the alkalinity of the duodenal contents is desirable, the patient up to now had to be subjected to two different test meals on two days. In order to facilitate this examination for the patient and also to increase its worth I constructed a "Simultaneous Gastro-Duodenal Aspirator." By means of this instrument gastric and duodenal contents can be obtained at the same time and comparisons made between the workings of these two divisions (stomach and duodenum) of the digestive apparatus.

---

[1] Demonstrated at the Clinical Society of the Lenox Hill Hospital on October 11, 1918.

The gastro-duodenal aspirator (see Fig. 44) consists of a long soft rubber tube (about 12F) with two separate canals, one leading to a perforated end capsule, the other to a perforated hollow metal piece, lying about 25 cm. above the end capsule (or proximal end of the tube). The distal end of the tube branches off into two side tubes provided with stopcocks (marked "D"—duodenum and "S"—stomach). Like the simple duodenal tube, the gastro-duodenal aspirator is provided with the usual markings starting from the capsule end. Mark I is situated at 40, mark II at 55, mark III at 70 cm. from the capsule, and ultimately 80 cm. is stamped on the tube.

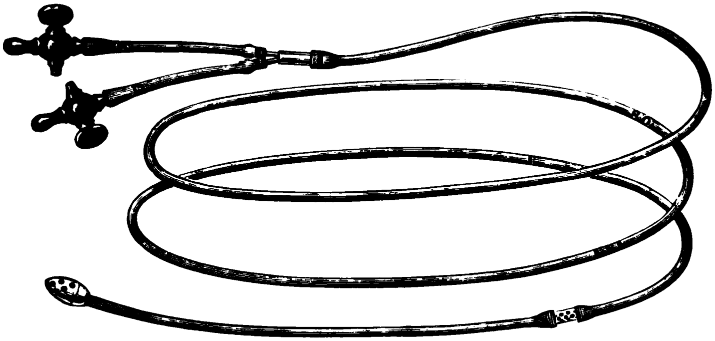

FIG. 44.—The simultaneous gastro-duodenal aspirator.

When the aspirator is in the digestive tract and the capsule has reached the duodenum, the perforated metal piece is within the stomach, provided the capsule is at a distance of 60 to 78 cm. from the lips. All along this position of the aspirator it will be possible to obtain simultaneously gastric juice and duodenal secretions.

Mode of Procedure.—The gastro-duodenal aspirator is introduced in the same manner as the usual duodenal tube. When the instrument has reached the duodenum

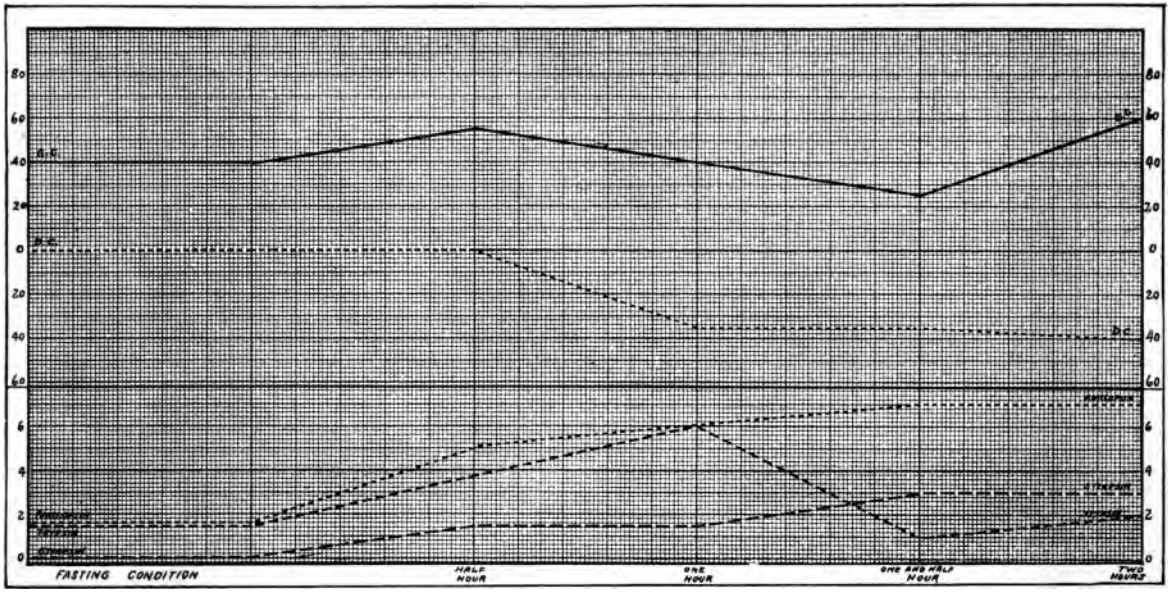

Fig. 45.—Mrs. H. ——. Simultaneous examination of gastric and duodenal contents in fasting condition and after bouillon.

Upper: reaction curve of acidity and alkalinity expressed in number of c.c. of $\frac{1}{10}$ normal NaOH or HCl solutions respectively to neutralize 100 c.c.

Lower: activity of ferments expressed in mm. of agar tubes digested.

it is best to first let it slip down to the 80 mark. The tube is then pulled out a little bit from the mouth, so that about 2 cm. in front of the 80 mark are outside of the lips. At this moment aspiration of both stomach and duodenum can be performed. Fractional examinations of the stomach and duodenum can also be undertaken at the same time.

The following curves of the acid secretion of the stomach and the alkalinity of the duodenal contents, observed on the same patient at the same time, illustrate the practicability of the gastro-duodenal aspirator.

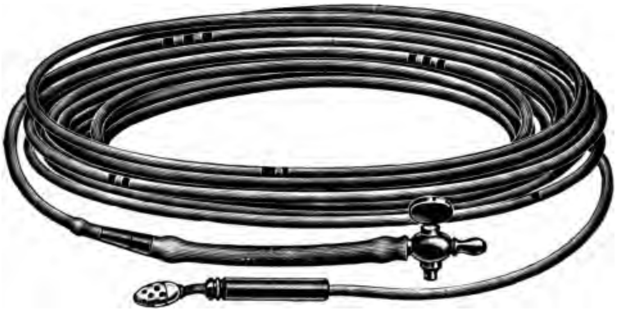

FIG. 46.—The intestinal tube.

THE INTESTINAL TUBE[1]

With the object of making the entire small intestine and the cecum accessible to direct examination and therapeutic measures, the intestinal tube has been devised. The apparatus consists of a soft rubber tube of about the same diameter as the duodenal tube, fifteen to twenty feet long (Fig. 46). At one end is fastened a perforated metal capsule with numerous openings. The opposite or outside end contains a stopcock and an attachment arrangement similar to that of the duodenal tube. Through the entire length of the tube and firmly fastened to both ends runs a strong braided silk thread (English No. 3). The tube is marked with a paint of asphalt and lead. The first 80 cm. are marked the same as the duodenal tube, and further down it is marked in meter and half meter divisions. The tube is provided with a hard rubber holder (like the delineator) and wound upon a reel in such a manner that the capsule end of the tube and the holder form the free end on the reel.

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[1] An Intestinal Tube, N. Y. Med. Journal, Sept. 13, 1919.

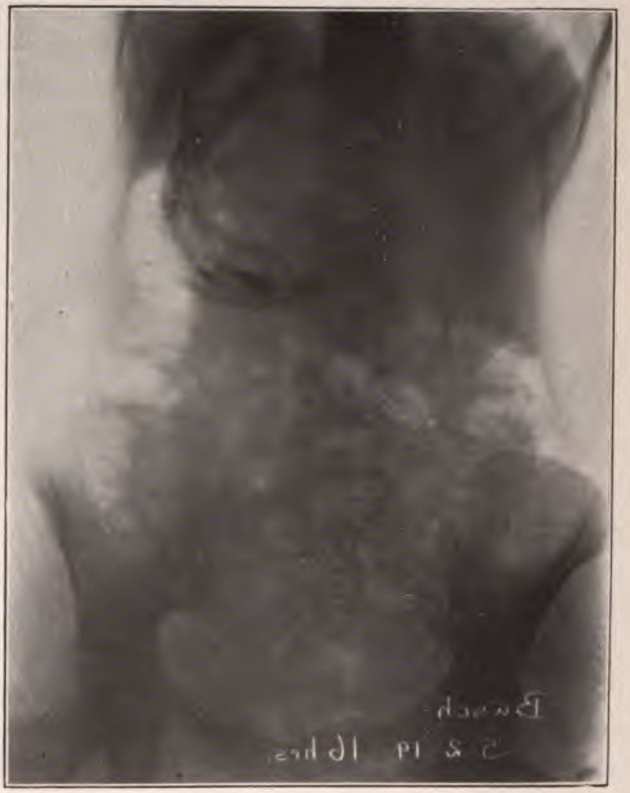

FIG. 47.—Radiogram of the intestinal tube in Miss B. twenty-two hours after insertion. The tube is seen curled up in the stomach.

Method of Use.—The intestinal tube is best given in the morning after a light breakfast. The capsule is put deep into the pharynx and the patient given water to drink, and the instrument thus starts on its journey to the stomach and further down through the entire small intestine. The reel is kept in a pocket not too far from the mouth, and there should be no obstacle to the unwinding of the tube from the reel. *X*-ray pictures should be taken or fluoroscopy

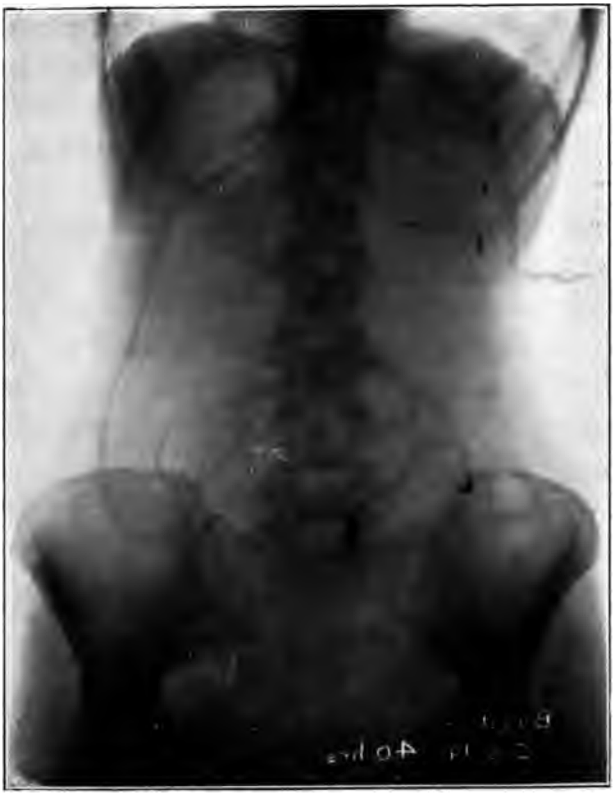

Fig. 48.—Radiogram of the intestinal tube in Miss B. forty hours after insertion. The tube is seen in the small intestine.

practised every two hours during the day until the capsule appears in the duodenum and later in the cecum.

When employing the intestinal tube the following rules should be observed:

1. In introducing the tube attach it in such a manner that it can not go beyond 60 cm. This can be done by fastening the tube to the reel with a rubber band after enough length has been unwound so that 60 cm. can enter the mouth.

2. Release the tube from one-half to one hour later. The patient should not swallow the tube intentionally and should not keep his mouth closed too tightly so as to let it go whenever there is a pull.

3. At night the holder should be pushed up to the teeth and held there in the same manner as when smoking a cigar. The holder may be fastened to a tooth where feasible or to the cheek, but care must be taken not to interfere with the gliding of the tube.

4. After the *X*-ray shows the tube in the duodenum, 30–50 cm. should be unwound from the reel from time to time so that it hangs in a loose curve. Otherwise the tube should not be allowed to go further as it may curl up in the stomach.

5. When washing or dressing, the patient must be careful not to interfere with the tube.

6. When eating, the tube should be fastened to the reel with a rubber band so that not more than 30–50 cm. can move into the stomach during the meal. After eating, the rubber can be taken off and the tube released.

7. An *X*-ray picture should be taken or fluoroscopy practised a few minutes after the tube has entered the stomach and then every two to three hours, from 9 A.M.

to 5 P.M. until the capsule end appears in the cecum, when the last plate is taken.

8. The tube should be left *in situ* for the entire period of examination or treatment. The patient eats and drinks in the usual way, there being no interference from the position of the tube.

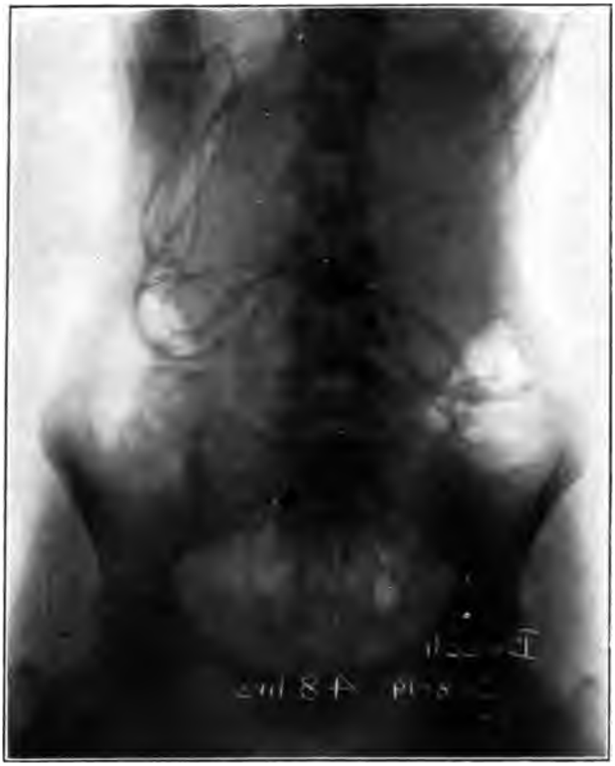

FIG. 49.—The same forty-eight hours after insertion. The tube is seen along the greater portion of the small intestine.

9. After the examinations or therapeutic measures have been finished, the tube can be withdrawn through the mouth or made to go through the rectum. Withdrawal

by the mouth should be done gently. When much resistance is encountered the operator should wait awhile, then resume gentle pulling until the entire tube has been disengaged. If it is desired to let the tube pass through

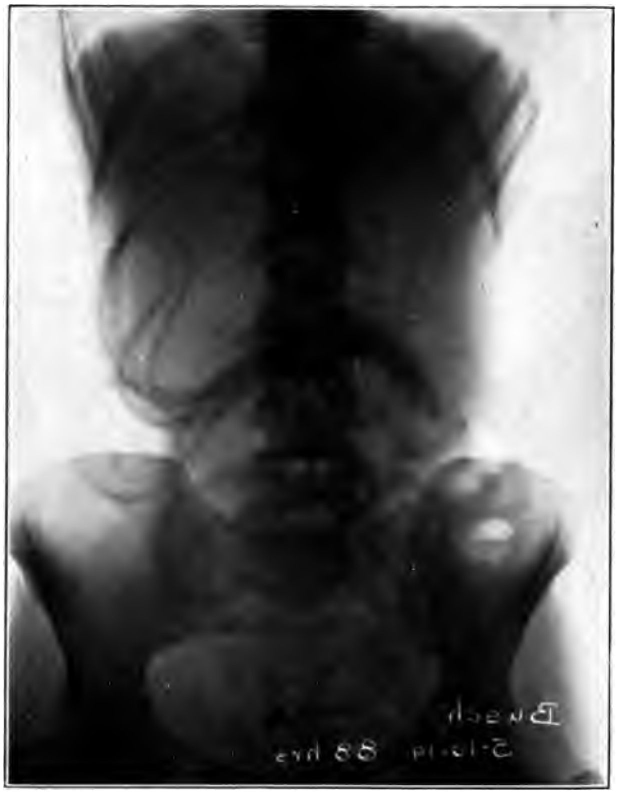

FIG. 50.—The same eighty-eight hours afterward. The end of the tube is visible in the lower part of the pelvis.

the rectum, the hard rubber endpiece is removed or the tube cut at the lips and made to go into the stomach. After a few days it will be found in the stools.

The intestinal tube thus far can be employed for the following purposes:

1. Like the delineator, it shows the course of the duodenum and the small intestine and in this way is of diagnostic help.

2. It enables the physician to instill fluids (nutriment or medication) at any place along the small intestine and probably also at the cecum.

THE GASTRIC INTRODUCER[1]

(An appliance for the introduction of gastro-duodenal instruments into the stomach.)

Most of the instruments described above have to be swallowed by the patient. They consist of thin, long pliable tubes, which present very little resistance and do not annoy the patient when in the digestive tract. Others are attached to a silk thread with the same object in view.

While in the great majority of cases there is no difficulty in their introduction, the patient usually being able to swallow them easily with water, we meet in rare instances with exceptions to this rule.

To this class of cases belong patients who never can swallow a pill or capsule, and highly neurotic individuals, who can not apparently do what they are instructed to perform. Again, there are instances in which a cardiospasm appears and prevents the entrance of the instrument into the stomach.

To obviate just such difficulties an appliance was constructed which makes it possible to introduce the instrument desired directly into the stomach without any effort at swallowing on the part of the patient.

The instrument consists of a whalebone stem (which can be arranged in the divisible form), at the end of which is attached a hollow metal cap with a wide incision on one side and rounded off edges.

---

[1] Max Einhorn: An Appliance for the Introduction of Instruments into the Stomach, Medical Record, March 7, 1914.

This cap fits loosely over the top of the capsule of the instrument to be introduced, the incision serving for the reception of the tube or thread attached. Caps of various sizes can be screwed on to the whalebone stem (Fig. 51), fitting the various instruments.

When introducing the instrument desired, the capsule top is lodged in the metal cap, and the thread or the tube of the instrument kept taut along the whalebone stem. The latter is then pushed through the throat and esophagus into the stomach of the patient. When there the tube or thread is released, the whalebone pushed a little further down, slightly shaken—this serves to separate the instrument from the cap more efficiently—and then slowly retracted. This instrument is termed "Gastric Instrument Introducer," or "Gastric Introducer,"[1] or "Gastric Pusher," and can be used for the introduction of the duodenal pump, the pyloric dilator, stomach bucket, duodenal bucket, etc.

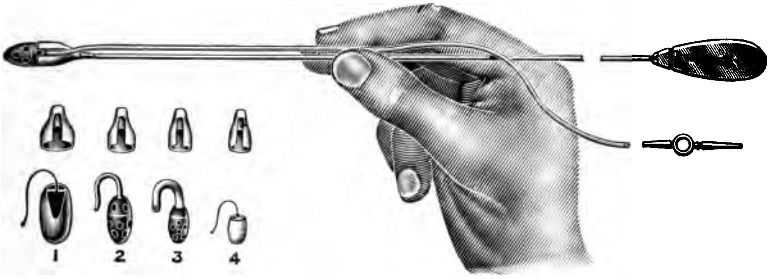

FIG. 51.—The gastric pusher or introducer. The top line shows the introducer with the deglutible electrode ready for use. The middle line illustrates the different caps: (1) for the stomach bucket: (2) for the deglutible electrode; (3) duodenal pump, and (4) duodenal bucket which are represented in the third line underneath their corresponding caps.

---

[1] The "Gastric Introducer" can be obtained at Tiemann & Co., 107 East 28th St., New York City, N. Y.

CHAPTER VI

THE PRACTICAL USE OF THESE NEW INSTRUMENTS

While some of the above instruments have not been fully utilized as yet and have, at present, a mere theoretical value, most of them have already shown their practical use and worth concerning diagnosis and treatment.

Diagnosis.—Although the diagnosis of organic pyloric obstruction and spasm of the pylorus can be made as above stated by the duodenal bucket, likewise the duodenal pump, the degree of stenosis, however, can not be gauged as well by these instruments as by the pyloric dilator. The latter permits, after inflating and pulling it backward, an exact measurement of the pyloric outlet. The normal pylorus admits the passage of a balloon having a circumference of 52–54 mm. (52–54F.). In relative stenosis 42–44 can be passed without difficulty, while larger sized balloons encounter a distinct resistance.

When inflating the balloon to 75F. the pylorus (presenting resistance) can be generally pulled up easily to almost the cardia, without much force or pain. Mark I then appears at the lips, while the balloon has not passed the pylorus. It is possible to hold the latter near the cardia for quite a while, lifting the pylorus this way by holding the tube taut. If this phenomenon is found to exist, it appears to demonstrate that the pylorus is free from adhesions to the gall-bladder or liver. Conversely, if there be distinct pain, after pulling the pylorus 1–2 inches forward, it speaks in favor of adhesions around this outlet.

In the diagnosis of cardiospasm and impermeable cardiospasm the same instruments as for the pylorus can be utilized. While, however, simple cardiospasm is easily recognized without them, the diagnosis of impermeable cardiospasm gains in exactness by their aid. As is well known, in impermeable cardiospasm the esophageal bougie and the stomach tube fail to enter the stomach, while the duodenal instruments in the course of time find access to this cavity.

Treatment.—Stretching of the pylorus[1] by means of the pyloric dilator (or the double balloon pyloric dilator) has proved of considerable value.

The indications for this procedure can thus be formulated:

(*a*) Stretching of the pylorus can be performed with advantage in all cases of pylorospasm, provided there is no fresh active ulcer in the pylorus or its immediate vicinity. If a fresh ulcer in this region is present, as evidenced by the thread test, a course of treatment should first be undertaken toward the cure of the ulcer. As soon as the thread test becomes negative, careful stretching of the pylorus can be undertaken. If, however, the ulcer shows no tendency to heal, or if there are frequent recurrences indicating exacerbations of the ulcerated process, an operation is indicated.

(*b*) Beginning benign stenosis of the pylorus forms a large field for the treatment by stretching with the same exceptions as mentioned in Paragraph (*a*).

(*c*) Advanced benign strictures of the pylorus, which can not be operated: either on account of the great underlying danger, like heart lesions, kidney, or liver, complications, advanced old age, or when the patient absolutely refuses surgical intervention, can likewise be subjected to the internal stretching. In this group the usual pyloric dilator frequently fails to pass, while the dilating catheter over the thread is still able to occasionally enter the pylorus.

---

[1] Max Einhorn: Further Experiences with Stretching of the Pylorus, American Journal of the Medical Sciences, Dec., 1913.

The method of stretching of the pylorus is not antagonistic to surgery. It works hand in hand with it. Where one procedure fails or is unfeasible, the other steps in as its helpmate.

Stretching of the cardia in impermeable cardiospasm can, likewise, be performed with the pyloric dilator and double balloon pyloric dilator. The usual cardio-dilators, failing to enter the cardiac opening, can not be applied in this malady. Recourse has, therefore, been taken to the pyloric dilator with great benefit to the patients. The double balloon pyloric dilator, by means of which stretching *in situ* (for several minutes, 5–10) can be accomplished, acts still more efficiently. A number of cases of impermeable cardiospasm have been markedly benefited by this mode of treatment.

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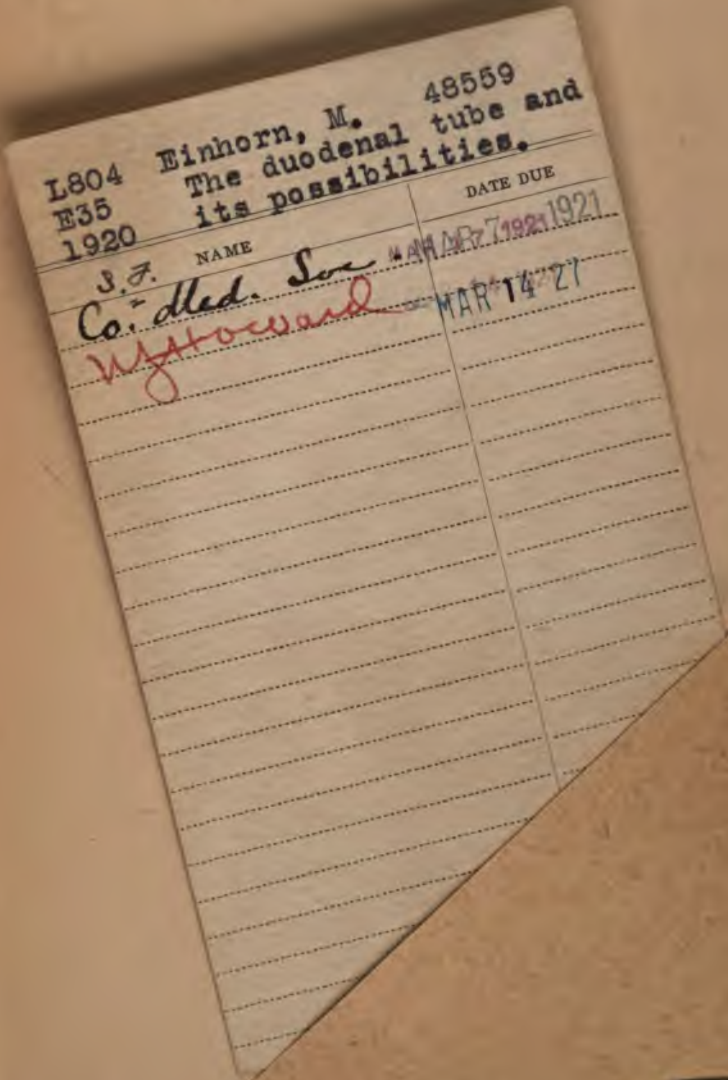

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